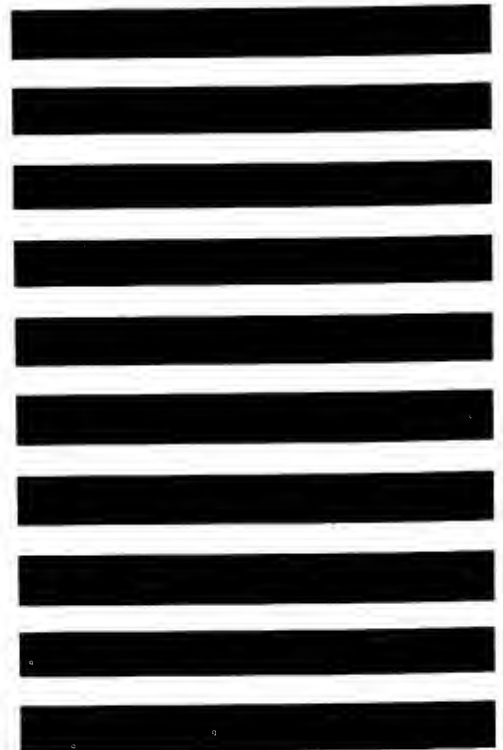


# LINEAR

## INTEGRATED CIRCUITS



# LINEAR

## INTEGRATED CIRCUITS

### INDEX



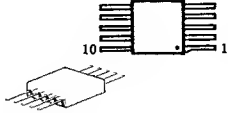
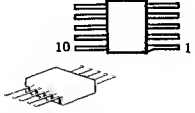
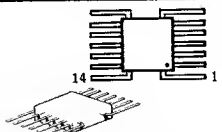
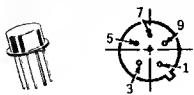
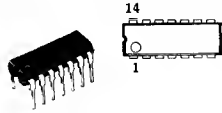
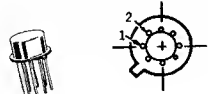
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# LINEAR INTEGRATED CIRCUITS

## APPLICATION SELECTOR GUIDE

LINEAR integrated circuits offer the design engineer a variety of functions for analog applications. This line includes operational, differential, high frequency, power, and sense amplifiers with a broad selection of operating characteristics and packaging.

### LINEAR IC PACKAGES

 <p><b>CASE 71 — 10 PIN</b> Suffix G after type number</p>	 <p><b>CASE 71A — 10 PIN</b> Suffix G after type number</p>	 <p><b>CASE 72 (TO-91)</b> Suffix F after type number</p>	 <p><b>CASE 73</b> Suffix F after type number</p>
 <p><b>CASE 83 (TO-86)</b> Suffix F after type number</p>	 <p><b>CASE 89 — 5 PIN</b> Suffix G after type number</p>	 <p><b>CASE 93 (TO-116)</b> Suffix P after type number</p>	 <p><b>CASE 96 — 8 PIN (TO-99)</b> Suffix G after type number</p>

## At a Glance

### OPERATIONAL AMPLIFIERS

TYPE				Open Loop Voltage Gain (A <sub>VOL</sub> )	Output Voltage Swing (V <sub>OUT</sub> , V <sub>P</sub> )	Common Mode Rejection Ratio (CM <sub>rej</sub> , dB)
Temperature Range						
−55 to +125°C	Case	0 to +75°C	Case			
MC1520	71A,72	—	—	1,500	± 4.0	−90
MC1530	71,72	MC1430	71,72,93	5,000	± 5.0	−75
MC1531	71,72	MC1431	71,72,93	3,500	± 5.0	−75
MC1533	71,72	MC1433	71,72,93	60,000*	± 12	−100
MC1535**	71,83	MC1435**	71,83,93	7,000	± 3.6	−90
—	—	MC1437**	93	45,000	± 14	−100
MC1539	96	MC1439	96	MC1539 120,000 MC1439 100,000	± 14	−100
MC1709	96,72	MC1709C	96,72,93	45,000	± 14	−90
MC1712	96,72	MC1712C	96,72,93	3,600	± 5.3	−100

\*Adjustable \*\*Dual

### HIGH FREQUENCY AMPLIFIERS

TYPE	Temperature	Case	Small-Signal Voltage Gain ( $A_v$ , dB)	Bandwidth (MHz)	Noise Figure (dB)	Comments
MC1110	—55 to +125°C	89	26 <sup>②</sup> @ 100 MHz	300 <sup>②</sup>	4.0 @ 100 MHz	High stability through low internal feedback for RF-IF applications.
MC1509	—55 to +125°C	73	40	40	4.5μV(5Hz-10MHz) <sup>①</sup>	Ideal for wideband video applications.
MC1510	—55 to +125°C	73, 96	40	40	4.5μV(5Hz-10MHz) <sup>①</sup>	
MC1550	—55 to +125°C	71	26 @ 60 MHz	200 <sup>②</sup>	5.0 @ 60 MHz	Constant input impedance over entire AGC range. RF-IF amplifier for communications equipment.
MC1552	—55 to +125°	71	34	40	5.0 @ 30 MHz	Three stage direct coupled common emitter cascade circuit with series feedback achieving extremely stable gain.
MC1553	—55 to +125°C	71	52	35	5.0 @ 30 MHz	Same as MC1552 except higher gain.

① Noise Voltage referred to input

② Useful transducer power gain

## POWER AMPLIFIERS

TYPE	Temperature	Case	Output Power (W)	Voltage Gain ( $A_v$ , V/V)	Total Harmonic Distortion (%)	Comments
MC1524	-55 to +125°C	71	1.0	38	0.6	Complementary output, low standby current drain.
MC1554	-55 to +125°C	71	1.0	10, 18, 36	0.4	Capable of single or split supply operation.

## DIFFERENTIAL AMPLIFIERS

TYPE	Temperature	Case	Differential Voltage Gain ( $A_{dd}$ , dB)	Output Voltage Swing ( $V_{out}$ , $V_{p-p}$ )	Common Mode Rejection ( $CM_{rej}$ , dB)	Differential Input Impedance ( $Z_{in}$ , $k\Omega$ )	Comments
MC1429	0 to +75°C	71	38	6.0	-75	40	Darlington inputs (high impedance).
MC1519	-55 to +125°C	71	73	14	-89	2.6	NPN inputs, PNP outputs, 1 MHz 8W.
MC1525	-55 to +125°C	71	43	8.0	-85	3.0	Conventional differential inputs, high gain, built-in temperature compensated current source.
MC1526	-55 to +125°C	71	36	8.0	-85	70	Same as MC1525 except Darlington inputs.
MC1529	-55 to +125°C	71	38	6.0	-75	50	Same as MC1429—specified over full temperature range.

## SENSE AMPLIFIERS

TYPE	Temperature	Case	Input Threshold ( $V_{th}$ , mVdc)	Voltage Gain ( $A_v$ , V/V)	Response Time ( $t_R$ , ns)	Comments
MC1440	0 to +75°C	71, 72, 93	17	85	50	Designed to detect bipolar differential signals derived by a core memory with cycle times as short as 0.5 $\mu$ s.
MC1540	-55 to +125°C	71, 72	17	85	30	
MC1541	-55 to +125°C	83	17	85	15	A dual-channel gated sense amplifier with separate wide band differential input amplifiers.
MC1710	-55 to +125°C	72, 96	0	1700†	40	A differential comparator providing accuracy and fast response time.
MC1710C	0 to +75°C	72, 96, 93	0	1700†	40	Same as MC1710—specified over limited temperature range.
MC1711	-55 to +125°C	71A, 72	0	1500†	40	A dual differential comparator providing accuracy and fast response time.
MC1711C	0 to +75°C	71A, 72, 93	0	1500†	40	Same as MC1711—specified over limited temperature range.

†  $A_{VOL}$

## STEREO PREAMPLIFIERS

TYPE	Temperature	Case	Open Loop Voltage Gain ( $A_{VOL}$ )	Input Offset Voltage (mV)	Output Voltage Swing ( $V_{rms}$ )	Channel Separation (dB)	Comments
MC1303	0 to +75°C	93	10,000	3.0	5.5	70	Two amplifiers on a single monolithic chip.

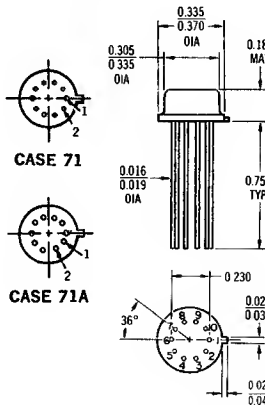
## LINEAR IC SYMBOLS AND DEFINITIONS

$A_{dd}$	Differential Voltage Gain (dB)	THD	Total Harmonic Distortion (%)
$A_p$	Transducer Power Gain (dB)	$t_{pd}$	Propagation Delay Time (ns)
$A_v$	Voltage Gain (dB or V/V, as specified)	$t_R$	Response Time (ns)
$A_{VOL}$	Open Loop Voltage Gain (V/V)	$V_{ic}$	Input Offset Voltage (mV)
$A_{v(s)}$	Single-Ended Voltage Gain (dB)	$V_{OH}$	Output Voltage, High (Vdc)
$CM_{rej}$	Common Mode Rejection Ratio (dB)	$V_{OL}$	Output Voltage, Low (Vdc)
$CMV_{in}$	Input Common Mode Voltage Swing ( $V_{pk}$ or $V_{p-p}$ , as specified)	$V_{out}$	Output Voltage Swing ( $V_{pk}$ or $V_{p-p}$ , as specified)
TCV <sub>io</sub>	Temperature Coefficient of Input Offset Voltage ( $\mu$ V/°C)	$V_{out}(CM)$	Common Mode Output Voltage (Vdc)
TCV <sub>th</sub>	Threshold Voltage Temperature Coefficient ( $\mu$ V/°C)	$V_{out}(dc)$	DC Output Voltage (Vdc)
		$V_{th}$	Input Threshold Voltage (mVdc)

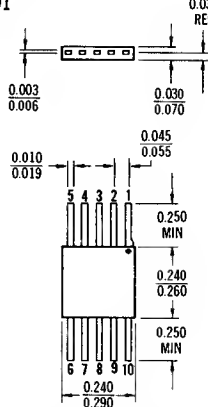
## CASE OUTLINES

### CASE 71, 71A

CASE 71A -  
PIN 10 UNDER  
TAB

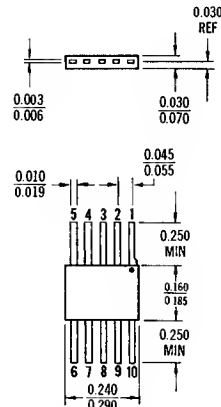


### CASE 72 10-LEAD FLAT PACKAGE TO-91



Lead 1 identified by color dot or by shoulder on lead. All leads electrically isolated from package.

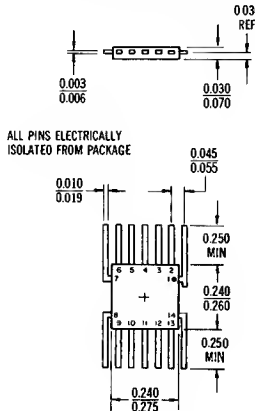
### CASE 73 10-LEAD FLAT PACKAGE



Lead 1 identified by color dot or by shoulder on lead. All leads electrically isolated from package.

### CASE 83 14-LEAD FLAT PACKAGE TO-86

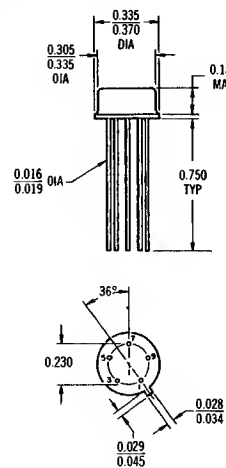
LEAD 1 IDENTIFIED BY COLOR  
DOT OR BY ELBOW ON PIN.



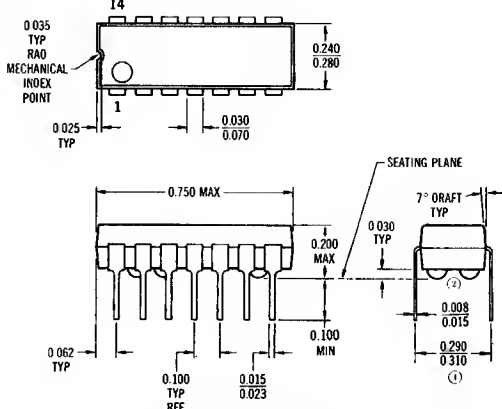
ALL PINS ELECTRICALLY  
ISOLATED FROM PACKAGE

All dimensions  
are in inches

### CASE 89

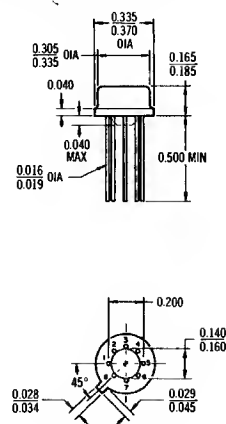


### CASE 93 TO-116 PACKAGE



- ① This dimension is measured at the seating plane.
- ② 4 insulating stand offs are provided.

### CASE 96 TO-99 PACKAGE

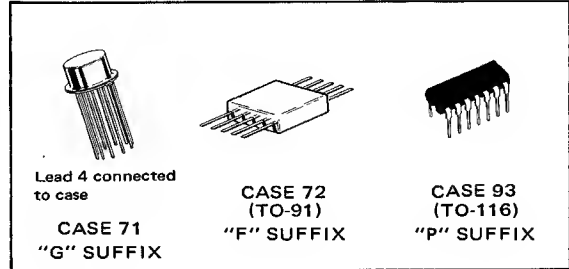


# OPERATIONAL AMPLIFIER

# OPERATIONAL AMPLIFIERS

## MC1430 MC1431

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.



### Typical Amplifier Features:

- High Open Loop Gain –  
 $AVOL = 74 \text{ dB}$  typical
- Large Output Voltage Swing –  
Typically  $\pm 5.0 \text{ V}$  @  $\pm 6.0 \text{ V}$  Supply
- Low Output Impedance –  
 $Z_{out} = 25 \text{ ohms}$  typical
- High Slew Rate –  
Typically  $4.5 \text{ V}/\mu\text{s}$

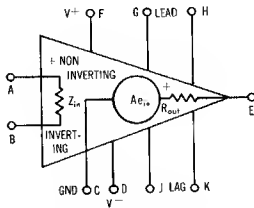


FIGURE 1 - EQUIVALENT CIRCUIT BOTH TYPES

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$	+8	Vdc
Power Supply Voltage	$V^-$	-8	Vdc
Differential Input Signal	$V_{in}$	$\pm 5$	Volts
Load Current	$I_L$	10	mA
Power Dissipation (Package Limitation)	$P_D$		
Metal Can Derate above $25^\circ\text{C}$		680 4.6	mW mW/ $^\circ\text{C}$
Flat Package Derate above $25^\circ\text{C}$		500 3.3	mW mW/ $^\circ\text{C}$
Plastic Package Derate above $25^\circ\text{C}$		400 3.3	mW mW/ $^\circ\text{C}$
Operating Temperature Range*	$T_A$	0 to +75	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-55 to +150	$^\circ\text{C}$
Metal Can and Flat Package Plastic Package		-55 to +125	

\*For full temperature range ( $-55^\circ\text{C}$  to  $+125^\circ\text{C}$ ) see MC1530-MC1531 data sheet.

### PIN CONNECTIONS

Schematic	A	B	C	D	E	F	G	H	J	K
"F" & "G" Pkgs.	1	2	3	4	5	6	7	8	9	10
"P" Package	4	6	B	7	11	12	13	14	1	2

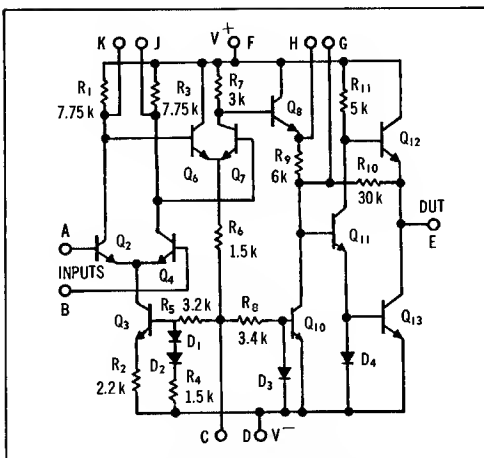


FIGURE 2 - MC1430 (STANDARD INPUT)

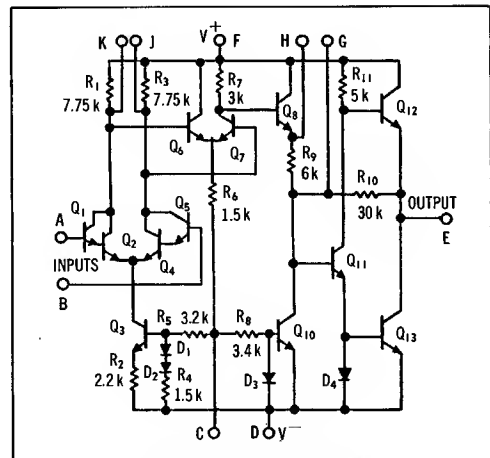
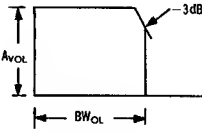
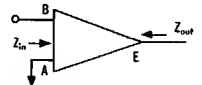
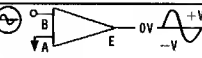
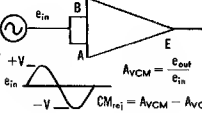
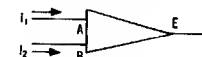
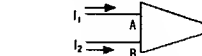
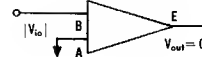


FIGURE 3 - MC1431 (DARLINGTON INPUT)

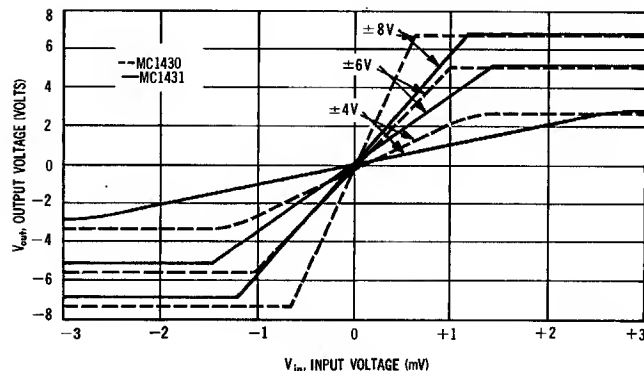
# MC1430, MC1431 (continued)

## ELECTRICAL CHARACTERISTICS (V<sup>+</sup> = +6 Vdc, V<sup>-</sup> = -6 Vdc, T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic Definitions*	Characteristic	Symbol	Min	Typ	Max	Unit
	Open Loop Voltage Gain	A <sub>VOL</sub>	69	74	—	dB
	MC1430		62	71	—	dB
	MC1430		3000	5000	—	V/V
	MC1431		1500	3500	—	V/V
	Open Loop Bandwidth (no roll-off capacitance)	BW <sub>OL</sub>	1.0	1.2	—	MHz
	MC1431		0.15	0.4	—	MHz
	Output Impedance (f = 20 Hz)	Z <sub>out</sub>	—	25	50	ohms
	MC1430, MC1431					
	Input Impedance (f = 20 Hz)	Z <sub>in</sub>	5k	15k	—	ohms
	MC1430		300k	600k	—	ohms
	Output Voltage Swing (1000 ohm Load)	V <sub>out</sub>	±4.0	±5.0	—	V <sub>peak</sub>
	MC1430, MC1431					
	Input Common Mode Voltage Swing	CMV <sub>in</sub>	±2.0	±2.5	—	V <sub>peak</sub>
	MC1430		±2.0	±2.2	—	V <sub>peak</sub>
	Common Mode Rejection Ratio	CM <sub>rej</sub>	65	75	—	dB
	MC1431		60	75	—	dB
	Input Bias Current (I <sub>b</sub> = (I <sub>1</sub> + I <sub>2</sub> ) / 2)	I <sub>b</sub>	—	5	15	μA
	MC1430		—	0.1	0.3	
	Input Offset Current (I <sub>io</sub> = I <sub>1</sub> - I <sub>2</sub> )	I <sub>io</sub>	—	0.4	4	μA
	MC1430		—	0.01	0.1	
	Input Offset Voltage	V <sub>io</sub>	—	2	10	mV
	MC1430		—	5	15	
	MC1431					
	DC Power Dissipation (Power Supply = ±6 V, V <sub>out</sub> = 0)	P <sub>D</sub>	—	110	150	mW
	Input Offset Voltage	V <sub>io</sub>	—	—	—	mV
	+75°C		—	3.0	12.0	
	0°C		—	3.0	11.0	
	+75°C		—	6.0	18.0	
	0°C		—	6.0	16.5	

\*All definitions imply linear operation (V<sub>io</sub> = 0)

FIGURE 4 — NORMALIZED DC OPEN LOOP TRANSFER CHARACTERISTICS



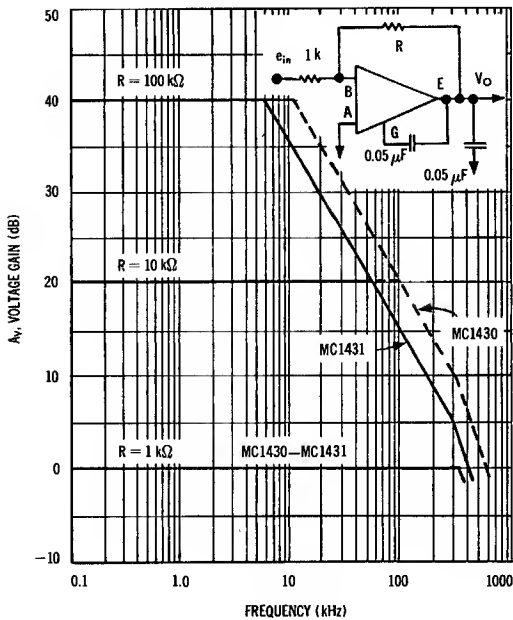
### RECOMMENDED OPERATING CONDITIONS

1. For High Slew Rate use Circuit A, Figure 9
2. For Minimum Noise use Circuit B, Figure 9
3. For operational stability Power Supply decoupling should be employed at all times.
4. Self Biasing network used to hold output voltage less than ±1 volt dc (quiescent)



FIGURE 5 — VOLTAGE GAIN versus FREQUENCY

(Roll-off Applied To Output Amplifier)



(Roll-off Applied To Input Differential Amplifier)

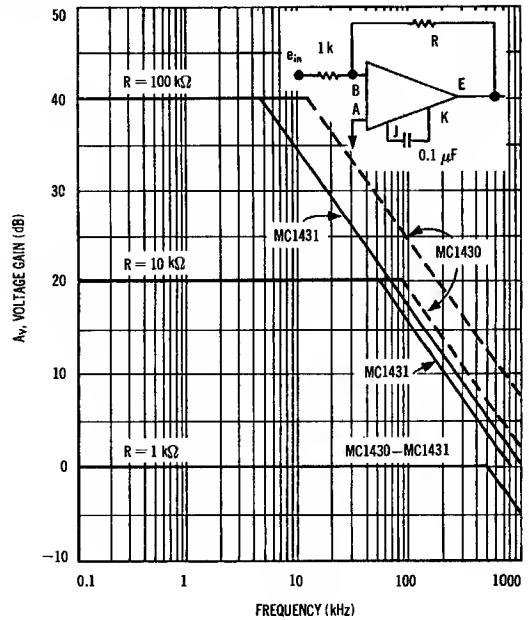


FIGURE 6 — OPEN LOOP VOLTAGE GAIN versus FREQUENCY

(Roll-off Applied To Input Differential Amplifier)

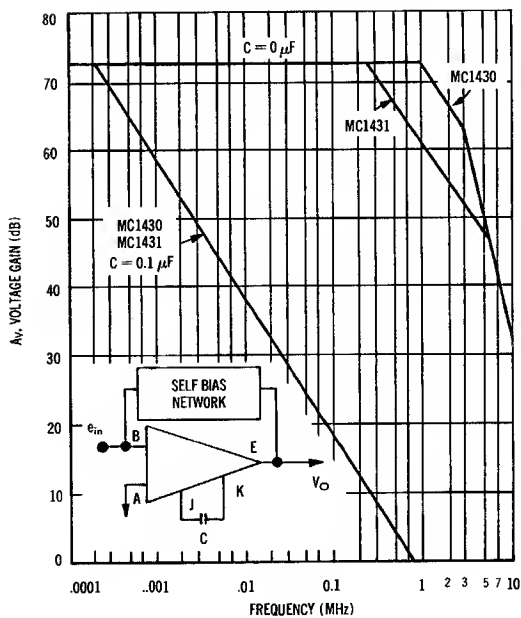
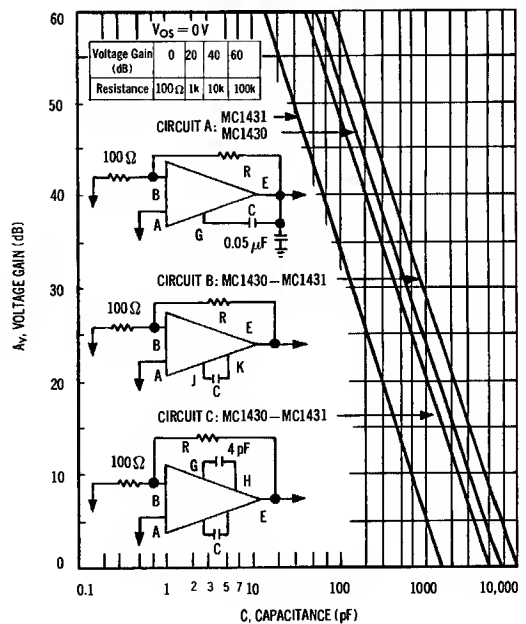


FIGURE 7 — VOLTAGE GAIN versus MINIMUM ROLLOFF CAPACITANCE





# MC1430, MC1431 (continued)

FIGURE 8 — MAXIMUM OUTPUT VOLTAGE SWING versus FREQUENCY

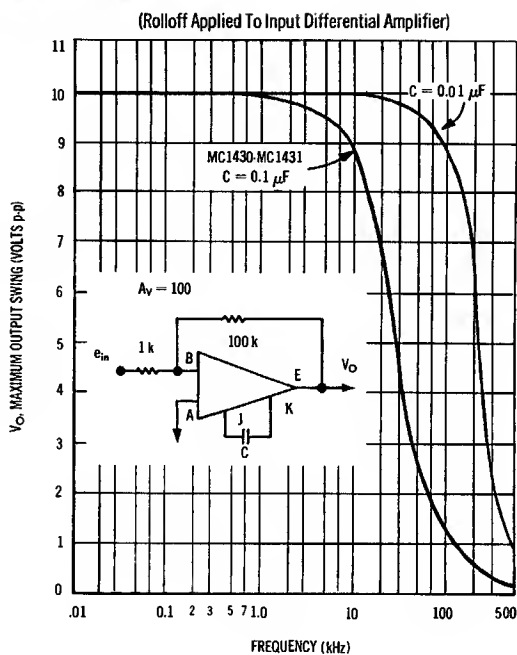
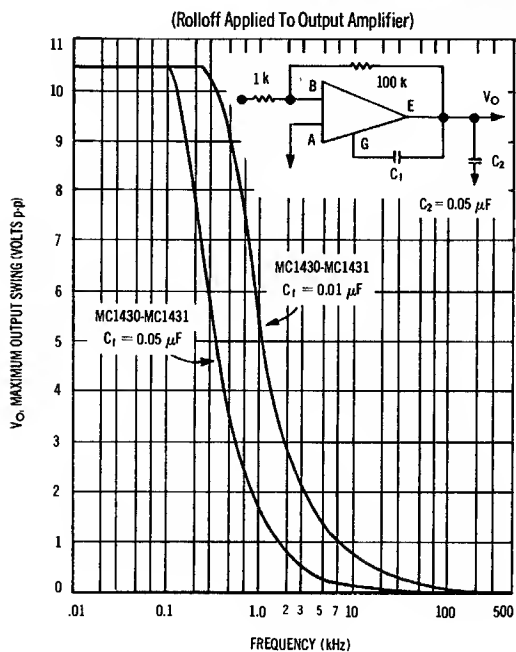


FIGURE 9 — SLEW RATE versus ROLLOFF CAPACITANCE

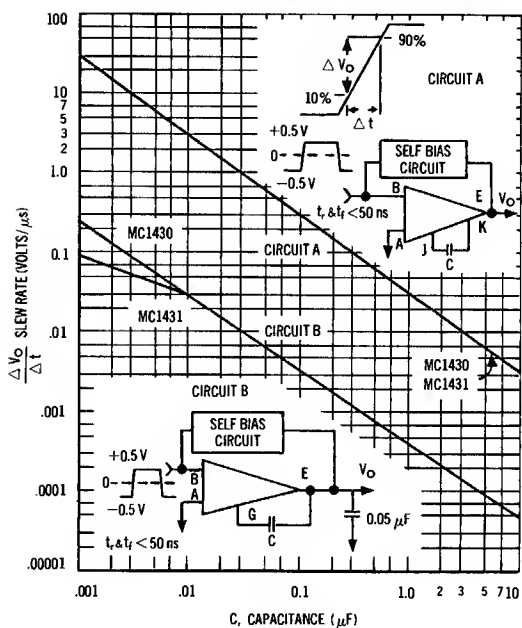
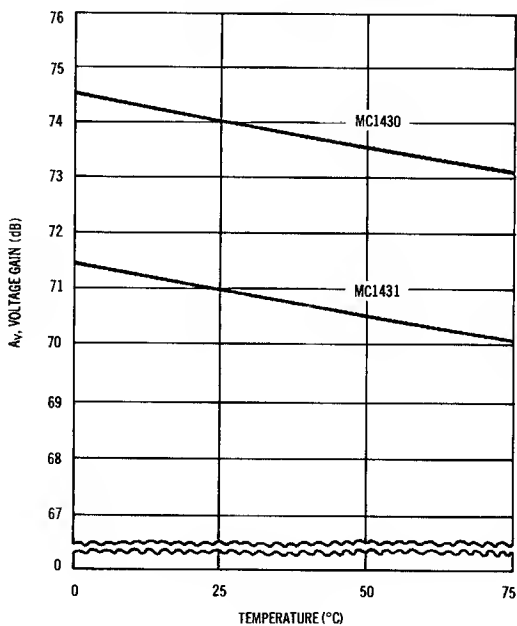


FIGURE 10 — OPEN LOOP VOLTAGE GAIN

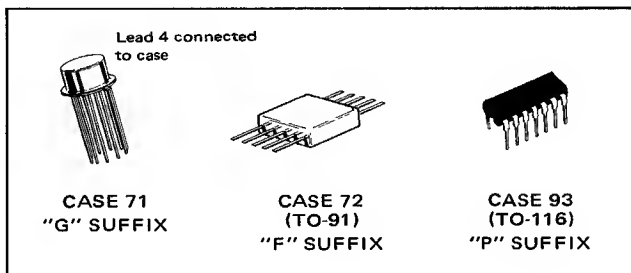


# OPERATIONAL AMPLIFIER

# OPERATIONAL AMPLIFIERS

## MC1433

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.



### Typical Amplifier Features:

- High-Performance Open Loop Gain Characteristics  
 $A_{VOL} = 60,000$  typical
- Low Temperature Drift  $\pm 8.0 \mu V/^{\circ}C$
- Large Output Voltage Swing  $\pm 13 V$  typical @  $\pm 15 V$  Supply
- Low Output Impedance  $Z_{out} = 100$  ohms typical
- Input Offset Voltage Adjustable to Zero

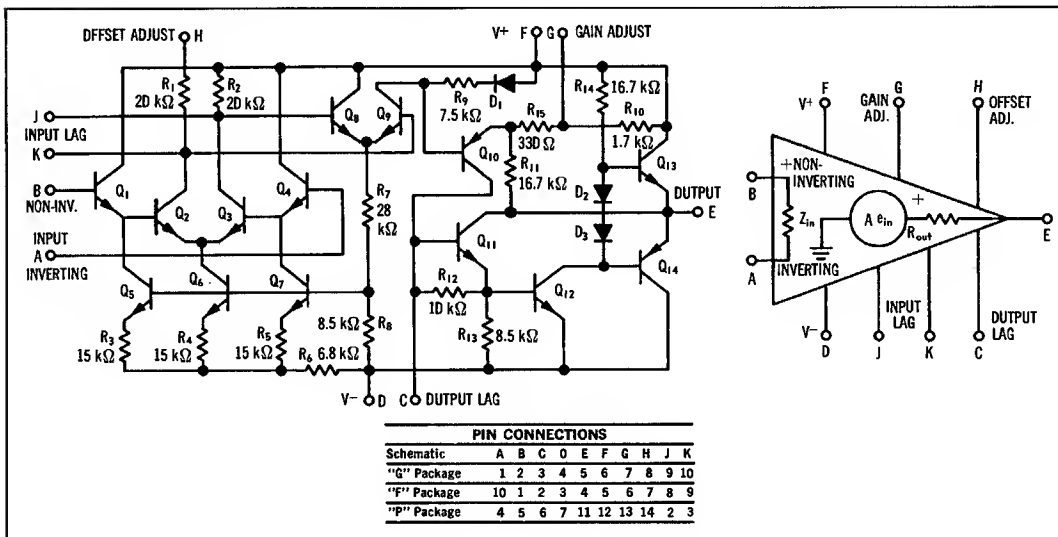
### MAXIMUM RATINGS ( $T_A = 25^{\circ}C$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+18 -18	Vdc Vdc
Differential Input Signal	$V_{in}$	$\pm 10$	Volts
Common Mode Input Swing	$CMV_{in}$	$\pm V^+$	Volts
Load Current	$I_L$	10	mA
Output Short Circuit Duration	$t_S$	1.0	s
Power Dissipation (Package Limitation)	$P_D$		
Metal Can		680	mW
Derate above $25^{\circ}C$		4.6	mW/ $^{\circ}C$
Flat Package		500	mW
Derate above $25^{\circ}C$		3.3	mW/ $^{\circ}C$
Plastic Package		400	mW
Derate above $25^{\circ}C$		3.3	mW/ $^{\circ}C$
Operating Temperature Range*	$T_A$	0 to $+75$	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	-65 to $+150$	$^{\circ}C$
Metal Can and Flat Package		-65 to $+125$	
Plastic Package			

\*For full temperature range ( $-55^{\circ}C$  to  $+125^{\circ}C$ ) and characteristic curves, see MC1533 data sheet.

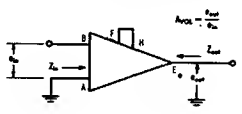
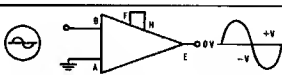
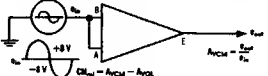
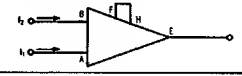
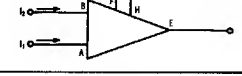

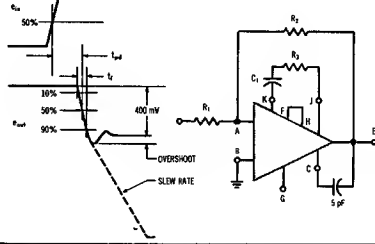
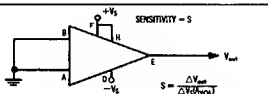
### CIRCUIT SCHEMATIC

### EQUIVALENT CIRCUIT



# MC1433 (continued)

## ELECTRICAL CHARACTERISTICS (V<sup>+</sup> = +15 Vdc, V<sup>-</sup> = -15 Vdc, T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic Definitions <sup>①</sup>	Characteristic	Symbol	Min	Typ	Max	Unit
	Open Loop Voltage Gain (V @ Pin G = +15 Vdc) (Pin G open) (V @ Pin G = +15 Vdc, T <sub>A</sub> = 0°C, +75°C) (Pin G open, T <sub>A</sub> = 0°C, +75°C)	A <sub>VOL</sub>	30,000 10,000 20,000 5,000	60,000 30,000 50,000 25,000	-	-
	Output Impedance (Pin G open, f = 20 Hz)	Z <sub>out</sub>	-	100	150	Ω
	Input Impedance (Pin G open, f = 20 Hz)	Z <sub>in</sub>	300	600	-	kΩ
	Output Voltage Swing (R <sub>L</sub> = 10 kΩ) (R <sub>L</sub> = 2 kΩ)	V <sub>out</sub>	±12 ±10	±13 ±12	-	V <sub>peak</sub>
	Input Common Mode Voltage Swing	CMV <sub>in</sub>	±8	±9	-	V <sub>peak</sub>
	Common Mode Rejection Ratio (V @ Pin G = +15 Vdc) (Pin G open)	CM <sub>rej</sub>	80 70	100 94	-	dB
	Input Bias Current (I <sub>b</sub> = (I <sub>1</sub> + I <sub>2</sub> ) / 2) (T <sub>A</sub> = +25°C) (T <sub>A</sub> = 0°C)	I <sub>b</sub>	-	0.5	2.0	μA
	Input Offset Current (I <sub>io</sub> = I <sub>1</sub> - I <sub>2</sub> ) (I <sub>io</sub> = I <sub>1</sub> - I <sub>2</sub> , T <sub>A</sub> = 0°C) (I <sub>io</sub> = I <sub>1</sub> - I <sub>2</sub> , T <sub>A</sub> = +75°C)	I <sub>io</sub>	-	0.1	0.50 0.75 0.75	μA
	Input Offset Voltage <sup>②</sup> (T <sub>A</sub> = 25°C) (T <sub>A</sub> = 0°C, +75°C)	V <sub>io</sub>	-	1.0	7.5 10.0	mV
	Step Response { Gain = 100, 15% overshoot, } { R <sub>1</sub> = 1 kΩ, R <sub>2</sub> = 100 kΩ, } { R <sub>3</sub> = 100 Ω, C <sub>1</sub> = 0.02 μF }  { Gain = 10, no overshoot, } { R <sub>1</sub> = 1 kΩ, R <sub>2</sub> = 10 kΩ, } { R <sub>3</sub> = 10 Ω, C <sub>1</sub> = 0.05 μF }  { Gain = 1, 20% overshoot, } { R <sub>1</sub> = 10 kΩ, R <sub>2</sub> = 10 kΩ, } { R <sub>3</sub> = 5 Ω, C <sub>1</sub> = 0.1 μF }	t <sub>f</sub> t <sub>pd</sub> dV <sub>out</sub> /dt <sup>③</sup>  t <sub>f</sub> t <sub>pd</sub> dV <sub>out</sub> /dt <sup>③</sup>  t <sub>f</sub> t <sub>pd</sub> dV <sub>out</sub> /dt <sup>③</sup>	-	0.15 0.06 11:0  0.3 0.1 1.5  0.2 0.3 0.8	-	μs μs V/μs  μs μs V/μs  μs μs V/μs
	Average Temperature Coefficient of Input Offset Voltage (T <sub>A</sub> = 0°C to +25°C) (T <sub>A</sub> = +25°C to +75°C)	TC <sub>Vio</sub>	-	10 8	-	μV/°C
	Average Temperature Coefficient of Input Offset Current (T <sub>A</sub> = 0°C to +25°C) (T <sub>A</sub> = +25°C to +75°C)	TC <sub>Iio</sub>	-	0.1 0.05	-	nA/°C
	DC Power Dissipation (Power Supply = ±15 V, V <sub>out</sub> = 0)	P <sub>D</sub>	-	125	240	mW
	Positive Supply Sensitivity (V <sup>-</sup> constant)	S <sup>+</sup>	-	50	200	μV/V
	Negative Supply Sensitivity (V <sup>+</sup> constant)	S <sup>-</sup>	-	50	200	μV/V

① All definitions imply linear operation

② Input offset voltage (V<sub>io</sub>) may be adjusted to zero by varying the potential on pin H

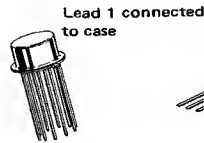
③ dV<sub>out</sub>/dt = Slew Rate

## DUAL OPERATIONAL AMPLIFIERS

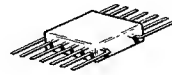
## OPERATIONAL AMPLIFIERS

### MC1435

... designed for use as summing amplifiers, integrators, or amplifiers with operating characteristics as a function of the external feedback components. Ideal for chopper stabilized applications where extremely high gain is required with excellent stability.



CASE 71  
"G" SUFFIX



CASE 83  
(TO-86)  
"F" SUFFIX



CASE 93  
(TO-116)  
"P" SUFFIX

#### Typical Amplifier Features:

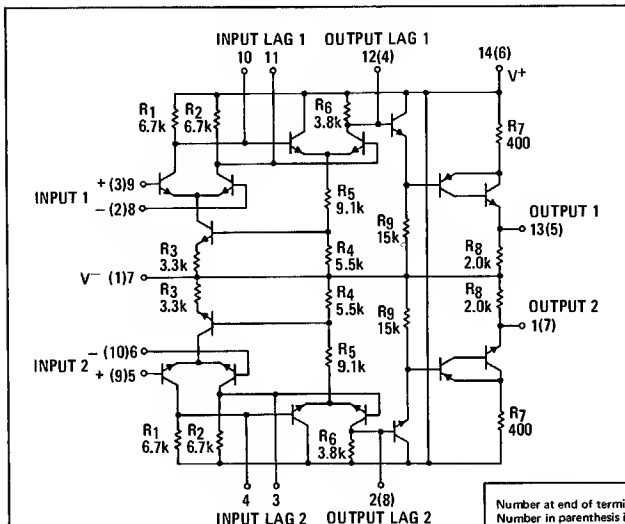
- High Open Loop Gain Characteristics –  $A_{VOL} = 7,000$  typical
- Low Temperature Drift –  $\pm 10 \mu V/^{\circ}C$
- Large Output Voltage Swing –  $\pm 3.6 V$  typ @  $\pm 6.0 V$  supply
- Low Input Offset Voltage –  $1.0 mV$
- Low Input Noise Voltage –  $0.5 \mu V$

#### MAXIMUM RATINGS ( $T_A = 25^{\circ}C$ unless otherwise noted)

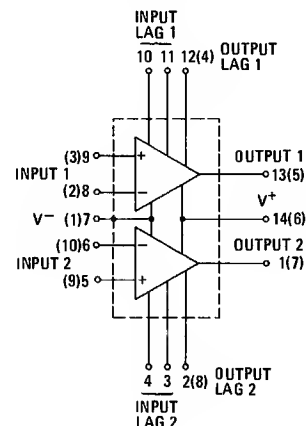
Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+9.0 -9.0	Vdc Vdc
Differential Input Signal	$V_{in}$	$\pm 5.0$	Volts
Common Mode Input Swing	$CMV_{in}$	+5.0 -4.0	Volts
Output Short Circuit Duration	$t_s$	Continuous	
Power Dissipation (package limitation)	$P_D$		
Metal Can		680	mW
Derate above $25^{\circ}C$		4.6	mW/ $^{\circ}C$
Flat Package		500	mW
Derate above $25^{\circ}C$		3.3	mW/ $^{\circ}C$
Plastic Package		400	mW
Derate above $25^{\circ}C$		3.3	mW/ $^{\circ}C$
Operating Temperature Range*	$T_A$	0 to +75	$^{\circ}C$
Storage Temperature Range	$T_{stg}$		$^{\circ}C$
Metal Can and Flat Package		-65 to +150	
Plastic Package		-65 to +125	

\*For full temperature range ( $-55^{\circ}C$  to  $+125^{\circ}C$ ) and characteristic curves, see MC1535 data sheet.

#### CIRCUIT SCHEMATIC



#### EQUIVALENT CIRCUIT



Number at end of terminal is pin number for both flat and plastic packages. Number in parenthesis is pin number for metal can package. Input lag available in flat and plastic packages.

# MC1435 (continued)

## ELECTRICAL CHARACTERISTICS (Each Amplifier) ( $V^+ = +6.0\text{Vdc}$ , $V^- = -6.0\text{Vdc}$ , $T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic Definitions (linear operations)	Characteristic	Symbol	Min	Typ	Max	Unit
$A_{VOL} = \frac{e_{out}}{e_{in}}$	Open Loop Voltage Gain ( $T_A = 0^\circ\text{C}$ to $+75^\circ\text{C}$ )	$A_{VOL}$	3,500 71	7,000 77	- -	V/V dB
	Output Impedance ( $f = 20\text{ Hz}$ )	$Z_{out}$	-	1.7	-	k $\Omega$
	Input Impedance ( $f = 20\text{ Hz}$ )	$Z_{in}$	10	45	-	k $\Omega$
	Output Voltage Swing ( $Z_L = 10\text{ k}\Omega$ )	$V_{out}$	5.0	7.0	-	V <sub>p-p</sub>
$A_{VCM} = \frac{e_{out}}{e_{in}}$ $CM_{rej} = A_{VCM} - A_{VOL}$	Input Common Mode Voltage Swing	$CMV_{in}$	+3.0 -2.0	+3.9 -2.7	- -	V <sub>peak</sub>
	Common Mode Rejection Ratio	$CM_{rej}$	60	90	-	dB
$I_b = \frac{I_1 + I_2}{2}$	Input Bias Current ( $I_b = \frac{I_1 + I_2}{2}$ , $T_A = +25^\circ\text{C}$ ) ( $T_A = 0^\circ\text{C}$ )	$I_b$	- -	1.2 3.6	5.0 10	$\mu\text{A}$
$I_{io} = I_1 - I_2$	Input Offset Current ( $I_{io} = I_1 - I_2$ , $T_A = 0^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2$ , $T_A = +75^\circ\text{C}$ )	$I_{io}$	- -	0.05 -	0.5 1.5	$\mu\text{A}$
$V_{io}$	Input Offset Voltage ( $T_A = 25^\circ\text{C}$ ) $R_S = 50\Omega$ ( $T_A = 0^\circ\text{C}$ to $+75^\circ\text{C}$ )	$V_{io}$	- -	1.0 -	5.0 7.5	mV
	Step Response Gain = 100, 30% overshoot, $R_1 = 4.7\text{ k}\Omega$ , $R_2 = 470\text{ k}\Omega$ , $R_3 = 150\Omega$ , $C_1 = 1,000\text{ pF}$	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	- - -	0.8 0.1 7.0	- - -	$\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$
	Gain = 10, 10% overshoot, $R_1 = 47\text{ k}\Omega$ , $R_2 = 470\text{ k}\Omega$ , $R_3 = 47\Omega$ , $C_1 = 0.01\text{ }\mu\text{F}$	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	- - -	0.4 0.3 4.0	- - -	$\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$
	Gain = 1, 5% overshoot, $R_1 = 47\text{ k}\Omega$ , $R_2 = 47\text{ k}\Omega$ , $R_3 = 4.7\Omega$ , $C_1 = 0.1\text{ }\mu\text{F}$	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	- - -	0.5 0.25 0.67	- - -	$\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$
	Average Temperature Coefficient of Input Offset Voltage ( $R_S = 50\Omega$ , $T_A = 0^\circ\text{C}$ to $+75^\circ\text{C}$ )	$TC_{Vio}$	-	3.0	-	$\mu\text{V}/^\circ\text{C}$
	Average Temperature Coefficient of Input Offset Current ( $T_A = 0^\circ\text{C}$ to $+75^\circ\text{C}$ )	$TC_{Iio}$	-	2.0	-	nA/ $^\circ\text{C}$
	DC Power Dissipation (Power Supply = $\pm 6.0\text{ V}$ , $V_{out} = 0$ )	$P_D$	-	100	180	mW
$S = \frac{\Delta V_{out}}{\Delta V_s(A_{VOL})}$	Positive Supply Sensitivity ( $V^-$ constant)	$S^+$	-	50	-	$\mu\text{V}/\text{V}$
	Negative Supply Sensitivity ( $V^+$ constant)	$S^-$	-	100	-	$\mu\text{V}/\text{V}$

## MATCHING CHARACTERISTICS

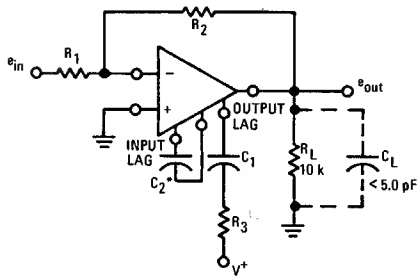
Same characteristic definitions as shown for each amplifier above.	Open Loop Voltage Gain	$A_{VOL1} - A_{VOL2}$	-	$\pm 1.0$	-	dB
	Input Bias Current	$I_{b1} - I_{b2}$	-	$\pm 0.15$	-	$\mu\text{A}$
	Input Offset Current	$I_{io1} - I_{io2}$	-	$\pm 0.02$	-	$\mu\text{A}$
	Average Temperature Coefficient	$TC_{Iio1} - TC_{Iio2}$	-	$\pm 0.1$	-	nA/ $^\circ\text{C}$
	Input Offset Voltage	$V_{io1} - V_{io2}$	-	$\pm 0.1$	-	mV
	Average Temperature Coefficient	$TC_{Vio1} - TC_{Vio2}$	-	$\pm 0.5$	-	$\mu\text{V}/^\circ\text{C}$
	Channel Separation (See Fig. 10) ( $f = 10\text{ kHz}$ )	$\frac{e_{out1}}{e_{out2}}$	-	-60	-	dB

①  $dV_{out}/dt$  = Slew Rate

TYPICAL OUTPUT CHARACTERISTICS

$V^+ = +6.0 \text{ Vdc}$ ,  $V^- = -6.0 \text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$

FIGURE 1 – TEST CIRCUIT



\*MC1435 F and P only.

FIGURE NO.	CURVE NO.	VOLTAGE GAIN	TEST CONDITIONS					OUTPUT NOISE (mV rms)
			$R_1(\Omega)$	$R_2(\Omega)$	$C_1(\mu\text{F})$	$R_3(\Omega)$	$C_2(\mu\text{F})$	
2	1	100	4.7 k	470 k	1,000	150	0	1.7
	1A	or 100	4.7 k	470 k	0	$\infty$	510	2.1
	2	10	47 k	470 k	10,000	47	0	1.0
	2A	or 10	47 k	470 k	0	$\infty$	5,000	2.1
	3	1	47 k	47 k	100,000	4.7	0	0.12
3	1	100	4.7 k	470 k	1,000	150	0	1.7
	1A	or 100	4.7 k	470 k	0	$\infty$	510	2.1
	2	10	47 k	470 k	10,000	47	0	1.0
	2A	or 10	47 k	470 k	0	$\infty$	5,000	2.1
	3	1	47 k	47 k	100,000	4.7	0	0.12
4	1	Av0 L	100	$\infty$	1,000	150	0	8.1
	1A	or Av0 L	100	$\infty$	0	$\infty$	510	8.1
	2	Av0 L	100	$\infty$	10,000	47	0	5.5
	2A	or Av0 L	100	$\infty$	0	$\infty$	5,000	5.5
	3	Av0 L	100	$\infty$	100,000	4.7	0	4.4
	1	Av0 L	100	$\infty$	1,000	150	0	8.1
	1A	or Av0 L	100	$\infty$	0	$\infty$	510	8.1
	2	Av0 L	100	$\infty$	10,000	47	0	5.5
	2A	or Av0 L	100	$\infty$	0	$\infty$	5,000	5.5
	3	Av0 L	100	$\infty$	100,000	4.7	0	4.4

FIGURE 2 – LARGE SIGNAL SWING  
versus FREQUENCY

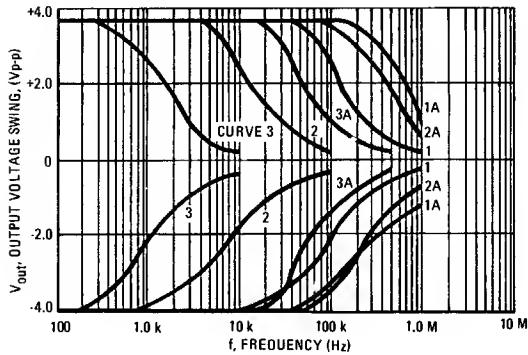


FIGURE 3 – VOLTAGE GAIN versus FREQUENCY

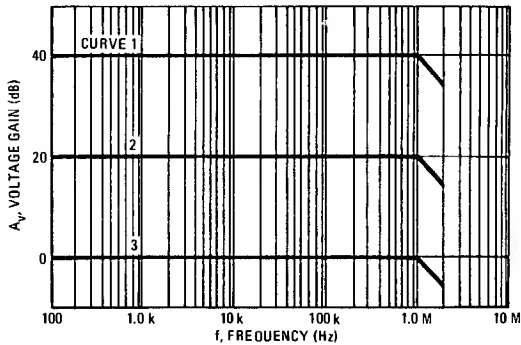


FIGURE 4 – OPEN LOOP VOLTAGE GAIN  
versus FREQUENCY

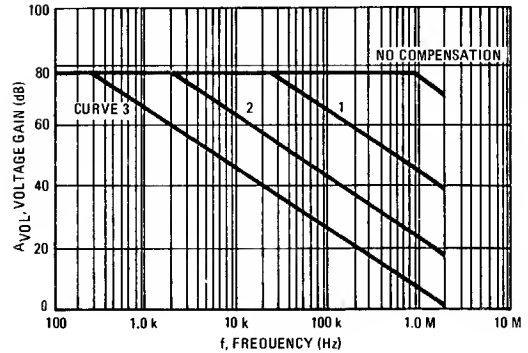


FIGURE 5 – INPUT OFFSET VOLTAGE  
versus TEMPERATURE

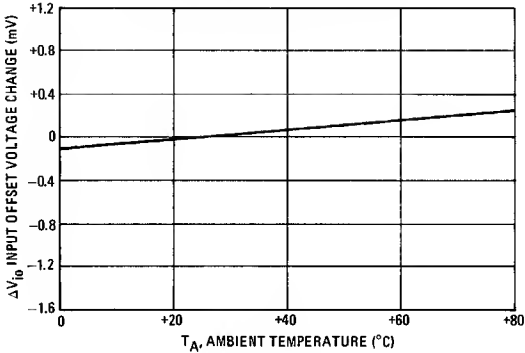


FIGURE 6 – VOLTAGE GAIN versus POWER SUPPLY VOLTAGE

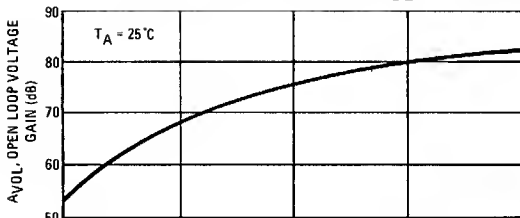


FIGURE 1 – COMMON MODE SWING versus POWER SUPPLY VOLTAGE

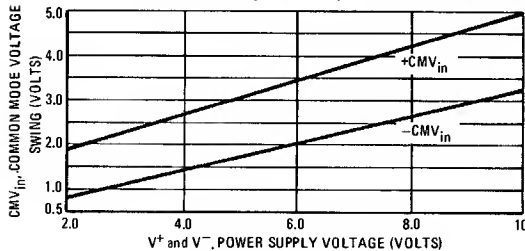


FIGURE 8 – POWER DISSIPATION versus POWER SUPPLY VOLTAGE

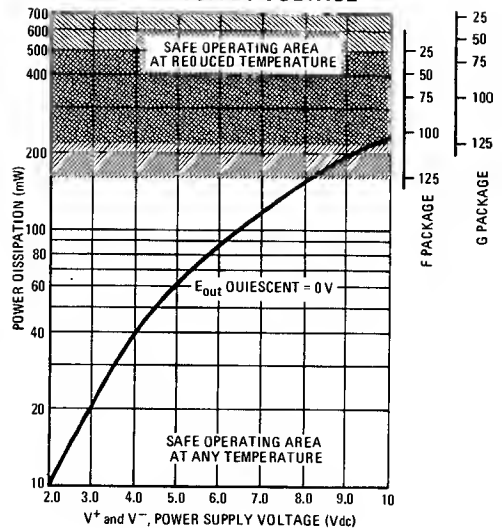


FIGURE 9 – OUTPUT NOISE VOLTAGE versus SOURCE RESISTANCE

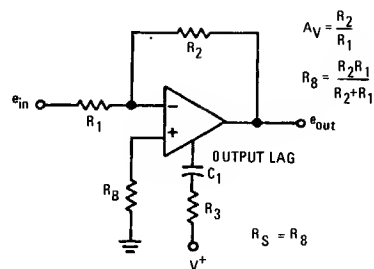
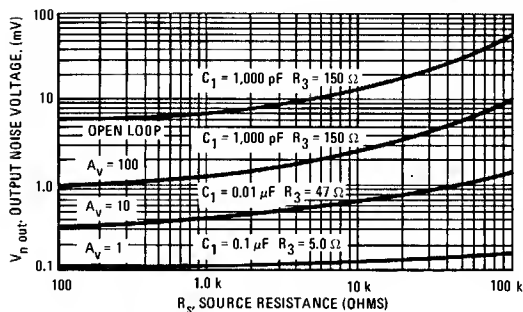
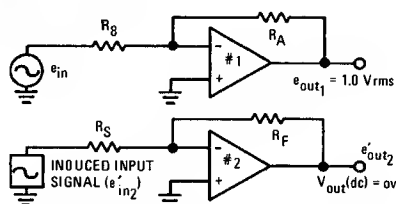
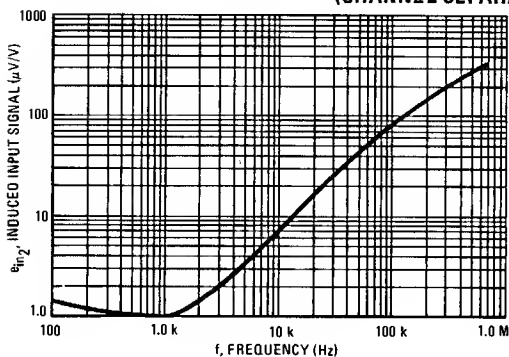


FIGURE 10 – INDUCED INPUT SIGNAL (CHANNEL SEPARATION) versus FREQUENCY



Induced input signal (μV of induced input signal in amplifier #2 per volt of output signal at amplifier #1)

$e'_{out2} = e_{in2} \times \frac{R_F}{R_S}$ , where  $e'_{out2}$  is the component of  $e_{out2}$  due only to lack of perfect separation between the two amplifiers.

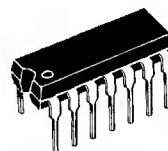
## MC1437P

(DUAL MC1709CP)

... designed for use as summing amplifiers, integrators, or amplifiers with operating characteristics as a function of the external feedback components. Ideal for chopper stabilized applications where extremely high gain is required with excellent stability.

### Typical Amplifier Features:

- High-Performance Open Loop Gain Characteristics  
 $A_{VOL} = 45,000$  typical
- Low Temperature Drift —  $\pm 3.0 \mu V/^{\circ}C$
- Large Output Voltage Swing —  
 $\pm 14 V$  typical @  $\pm 15 V$  Supply
- Low Output Impedance —  $Z_{out} = 30$  ohms typical



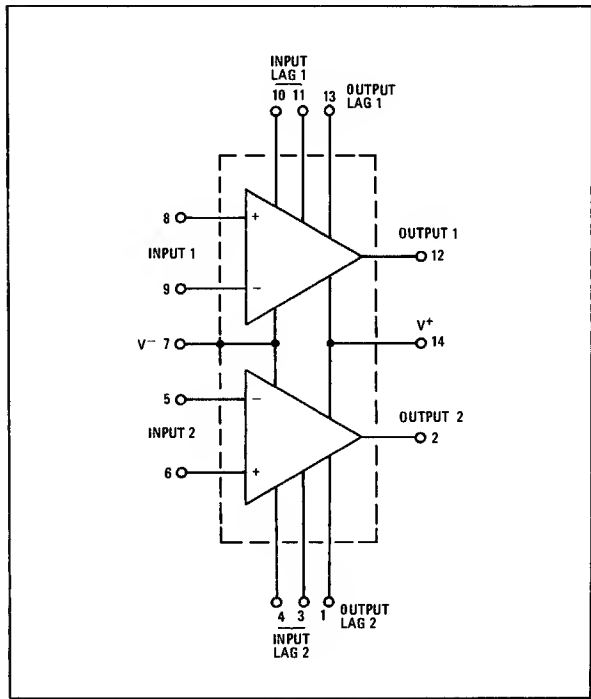
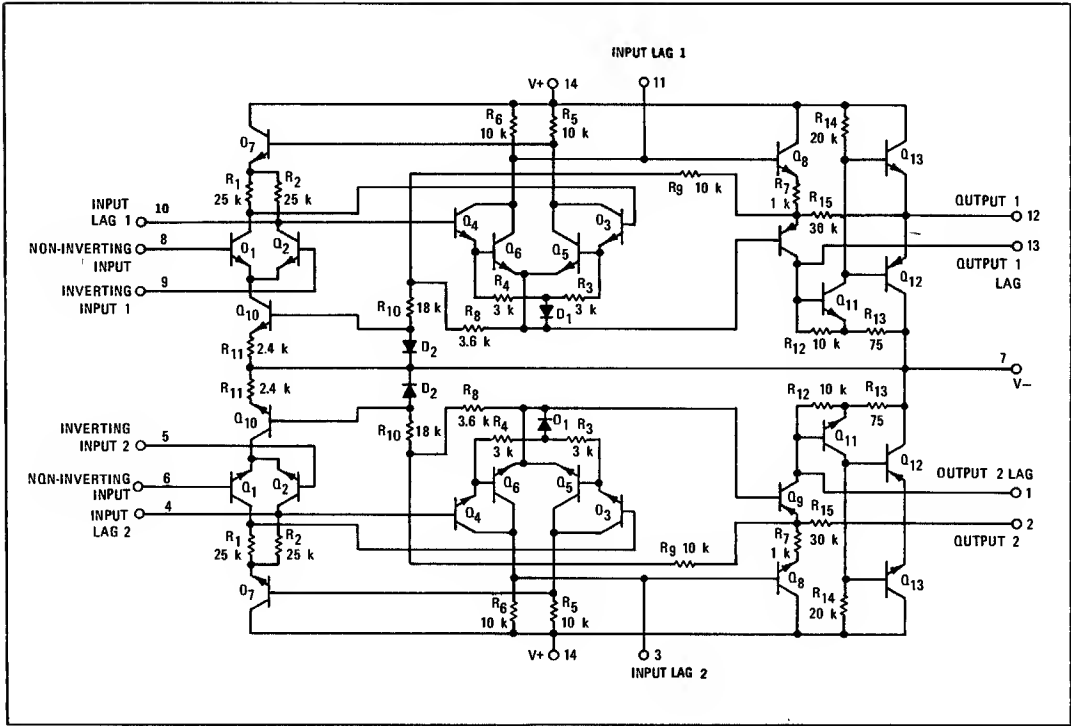
CASE 93  
(TO-116)  
"P" SUFFIX

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$	+18	Vdc
	$V^-$	-18	Vdc
Differential Input Signal	$V_{in}$	$\pm 5.0$	Volts
Common Mode Input Swing	$CMV_{in}$	$\pm V^+$	Volts
Output Short Circuit Duration	$t_S$	5.0	s
Power Dissipation (Package Limitation) Plastic Package Derate above $25^{\circ}C$	$P_D$	415 3.3	mW mW/ $^{\circ}C$
Operating Temperature Range	$T_A$	0 to +75	$^{\circ}C$
Storage Temperature Range Plastic Package	$T_{stg}$	-65 to +125	$^{\circ}C$



CIRCUIT SCHEMATIC



EQUIVALENT CIRCUIT

## ELECTRICAL CHARACTERISTICS (each amplifier)

(V<sup>+</sup> = +15 Vdc, V<sup>-</sup> = -15 Vdc, T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic Definitions (linear operation)	Characteristic	Symbol	Min	Typ	Max	Unit
	Open Loop Voltage Gain (R <sub>L</sub> = 5.0 kΩ, V <sub>out</sub> = ±10 V, T <sub>A</sub> = 0°C to +75°C)	A <sub>VOL</sub>	15,000	45,000	-	-
	Output Impedance (f = 20 Hz)	Z <sub>out</sub>	-	30	-	Ω
	Input Impedance (f = 20 Hz)	Z <sub>in</sub>	50	150	-	kΩ
	Output Voltage Swing (R <sub>L</sub> = 10 kΩ)	V <sub>out</sub>	±12	±14	-	V <sub>peak</sub>
	Input Common Mode Voltage Swing	CMV <sub>in</sub>	±8.0	±10	-	V <sub>peak</sub>
	Common Mode Rejection Ratio	CM <sub>rej</sub>	65	100	-	dB
	Input Bias Current $\left( I_b = \frac{I_1 + I_2}{2} \right)$ (T <sub>A</sub> = +25°C) (T <sub>A</sub> = 0°C)	I <sub>b</sub>	-	0.4	1.5	μA
			-	-	2.0	
	Input Offset Current (I <sub>io</sub> = I <sub>1</sub> - I <sub>2</sub> ) (T <sub>A</sub> = +25°C) (I <sub>io</sub> = I <sub>1</sub> - I <sub>2</sub> , T <sub>A</sub> = 0°C) (I <sub>io</sub> = I <sub>1</sub> - I <sub>2</sub> , T <sub>A</sub> = +75°C)	I <sub>io</sub>	-	0.05	0.5	μA
			-	-	0.75	
			-	-	0.75	
	Input Offset Voltage (T <sub>A</sub> = 25°C) (T <sub>A</sub> = 0°C, +75°C)	V <sub>io</sub>	-	1.0	7.5	mV
			-	-	10	
	Step Response { Gain = 100, 5% overshoot, R <sub>1</sub> = 1 kΩ, R <sub>2</sub> = 100 kΩ, R <sub>3</sub> = 1.5 kΩ, C <sub>1</sub> = 100 pF, C <sub>2</sub> = 3.0 pF } { Gain = 10, 10% overshoot R <sub>1</sub> = 1 kΩ, R <sub>2</sub> = 10 kΩ, R <sub>3</sub> = 1.5 kΩ, C <sub>1</sub> = 500 pF, C <sub>2</sub> = 20 pF } { Gain = 1, 5% overshoot R <sub>1</sub> = 10 kΩ, R <sub>2</sub> = 10 kΩ, R <sub>3</sub> = 1.5 kΩ, C <sub>1</sub> = 5000 pF, C <sub>2</sub> = 200 pF }	t <sub>f</sub> dV <sub>out</sub> /dt ①	-	0.8	-	μs
			-	0.38	-	μs
			-	12	-	V/μs
			-	0.6	-	μs
			-	0.34	-	μs
			-	1.7	-	V/μs
			-	2.2	-	μs
			-	1.3	-	μs
			-	0.25	-	V/μs
	Average Temperature Coefficient of Input Offset Voltage (R <sub>S</sub> = 50 Ω, T <sub>A</sub> = 0°C to +75°C) (R <sub>S</sub> ≤ 10 kΩ, T <sub>A</sub> = 0°C to +75°C)	TC <sub>Vio</sub>	-	1.5	-	μV/°C
			-	3.0	-	
	Average Temperature Coefficient of Input Offset Current (T <sub>A</sub> = 0°C to +25°C) (T <sub>A</sub> = +25°C to +75°C)	TC <sub>Iio</sub>	-	0.7	-	nA/°C
			-	0.7	-	
	DC Power Dissipation (Power Supply = ±15 V, V <sub>out</sub> = 0)	P <sub>D</sub>	-	150	225	mW
	Positive Supply Sensitivity (V <sup>-</sup> constant)	S <sup>+</sup>	-	10	200	μV/V
	Negative Supply Sensitivity (V <sup>+</sup> constant)	S <sup>-</sup>	-	10	200	μV/V

① dV<sub>out</sub>/dt = Slew Rate

## MATCHING CHARACTERISTICS

Same characteristic definitions as shown for each amplifier above.	Open Loop Voltage Gain	A <sub>VOL1</sub> -A <sub>VOL2</sub>	-	±1.0	-	dB
	Input Bias Current	I <sub>b1</sub> -I <sub>b2</sub>	-	±0.15	-	μA
	Input Offset Current	I <sub>io1</sub> -I <sub>io2</sub>	-	±0.02	-	μA
	Average Temperature Coefficient	TC <sub>Iio1</sub> -TC <sub>Iio2</sub>	-	±0.2	-	nA/°C
	Input Offset Voltage	V <sub>io1</sub> -V <sub>io2</sub>	-	±0.2	-	mV
	Average Temperature Coefficient	TC <sub>Vio1</sub> -TC <sub>Vio2</sub>	-	±0.5	-	μV/°C
	Channel Separation (f = 10 kHz)	e <sub>out 1</sub> e <sub>out 2</sub>	-	90	-	dB

TYPICAL OUTPUT CHARACTERISTICS

FIGURE 1—TEST CIRCUIT  
 $V^+ = +15\text{ Vdc}$ ,  $V^- = -15\text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$

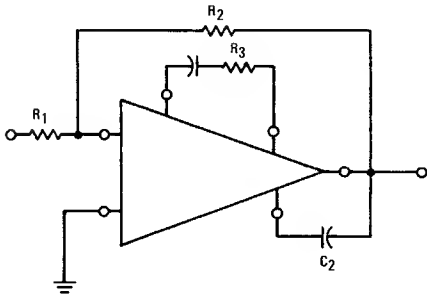


FIGURE NO.	CURVE NO.	VOLTAGE GAIN	TEST CONDITIONS					OUTPUT NOISE (mV rms)
			$R_1(\Omega)$	$R_2(\Omega)$	$R_3(\Omega)$	$C_1(\text{pF})$	$C_2(\text{pF})$	
2	1	1	10 k	10 k	1.5 k	5.0 k	200	0.10
	2	10	10 k	100 k	1.5 k	500	20	0.14
	3	100	10 k	1.0 M	1.5 k	100	3.0	0.7
	4	1000	1.0 k	1.0 M	0	10	3.0	5.2
3	1	1	10 k	10 k	1.5 k	5.0 k	200	0.10
	2	10	10 k	100 k	1.5 k	500	20	0.14
	3	100	10 k	1.0 M	1.5 k	100	3.0	0.7
	4	1000	1.0 k	1.0 M	0	10	3.0	5.2
4	1	$A_{VDL}$	0	0	1.5 k	5.0 k	200	5.5
	2	$A_{VDL}$	0	0	1.5 k	500	20	10.5
	3	$A_{VDL}$	0	0	1.5 k	100	3.0	21.0
	4	$A_{VDL}$	0	0	0	10	3.0	39.0
	5	$A_{VDL}$	0	0	0	0	3.0	—

FIGURE 2—LARGE SIGNAL SWING  
versus FREQUENCY

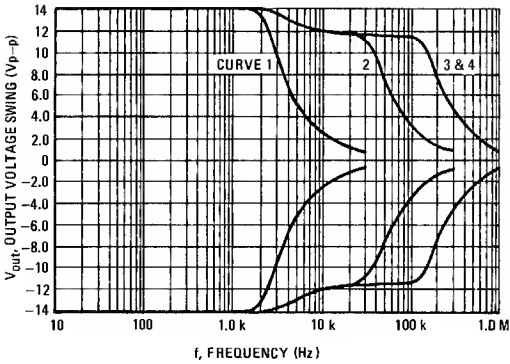


FIGURE 3—VOLTAGE GAIN versus FREQUENCY

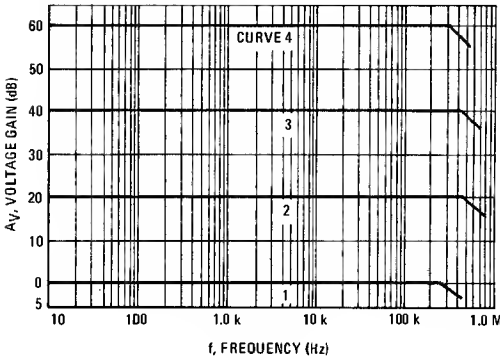


FIGURE 4—OPEN LOOP VOLTAGE GAIN  
versus FREQUENCY

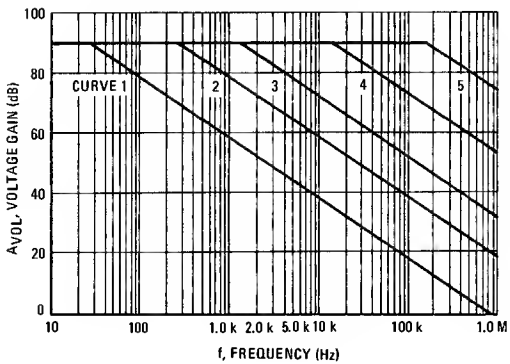


FIGURE 5—POWER DISSIPATION  
versus POWER SUPPLY VOLTAGE

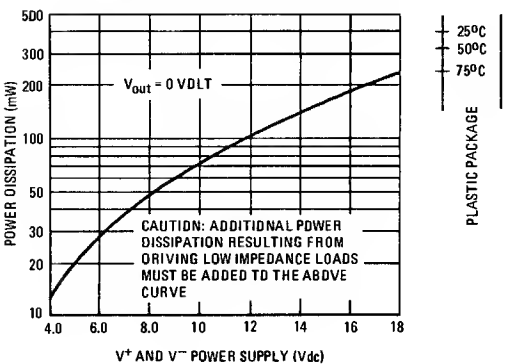


FIGURE 6—VOLTAGE GAIN  
versus POWER SUPPLY VOLTAGE

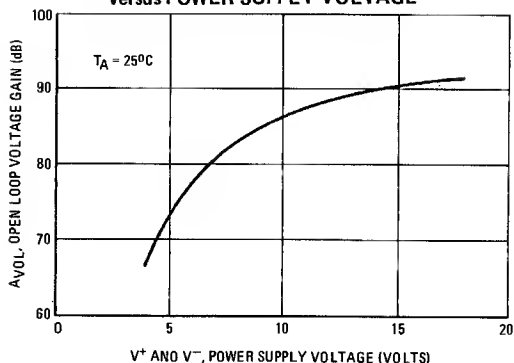


FIGURE 7—COMMON SWING  
versus POWER SUPPLY VOLTAGE

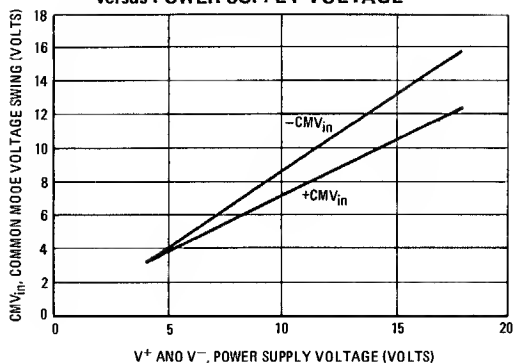


FIGURE 8—INPUT OFFSET VOLTAGE  
versus TEMPERATURE

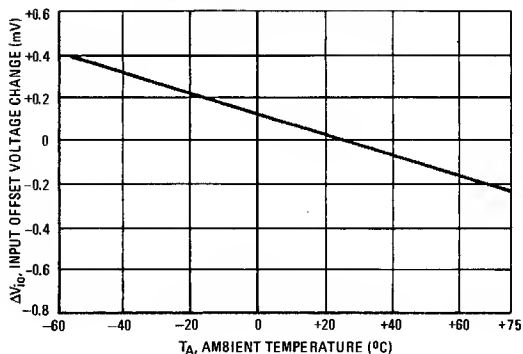


FIGURE 9—OUTPUT NOISE VOLTAGE  
versus SOURCE RESISTANCE

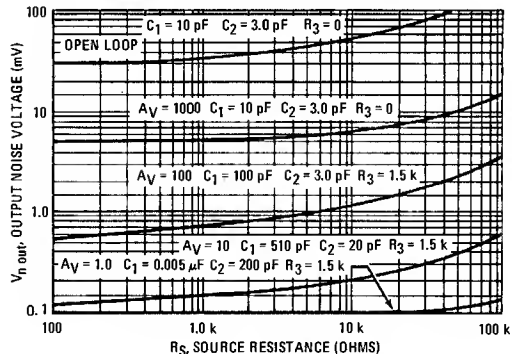
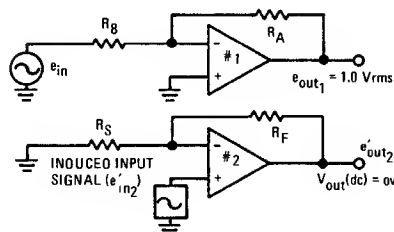
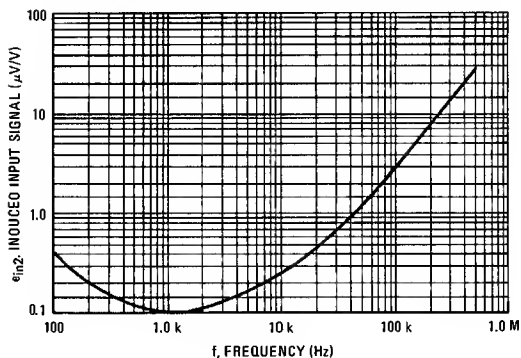


FIGURE 10—INDUCED INPUT SIGNAL  
(CHANNEL SEPARATION) versus FREQUENCY



Induced input signal (μV of induced input signal in amplifier #2 per volt of output signal at amplifier #1)

$e'_{out2} = e_{in2} (1 + \frac{R_F}{R_S})$ , where  $e'_{out2}$  is the component of  $e_{out2}$  due only to lack of perfect separation between the two amplifiers.

# MC1439G

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.

## Typical Amplifier Features:

- Low Input Offset Voltage – 2.0 mV typ
- Low Input Offset Current – 100 nA max
- Large Power-Bandwidth – 20 V<sub>p-p</sub> Output Swing at 10 kHz min
- Output Short-Circuit Protection
- Input Over-Voltage Protection
- Class AB Output for Excellent Linearity
- Slew Rate – 34 V/ $\mu$ s typ



Lead 4 connected to case

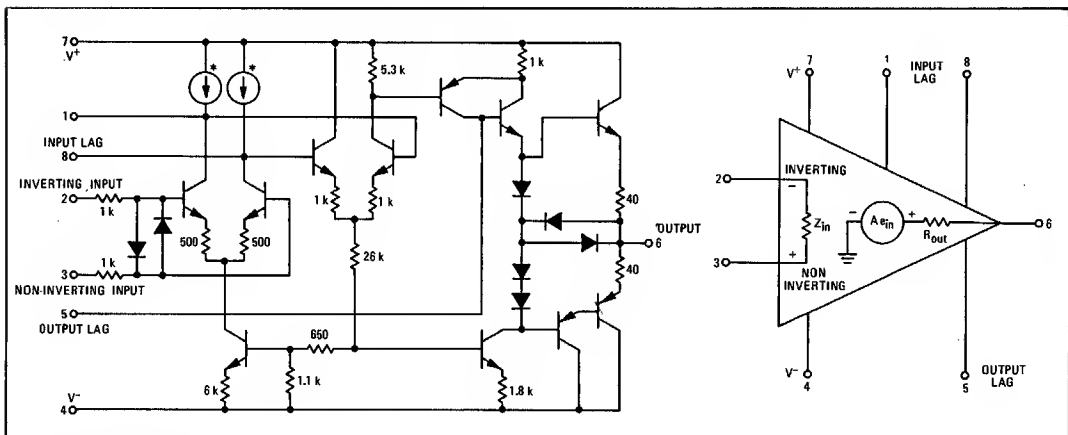
CASE 96  
(TO-99)  
"G" SUFFIX

## MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+18 -18	Vdc Vdc
Differential Input Signal	$V_{in}$	$\pm V^+$	Volts
Common Mode Input Swing	$CMV_{in}$	$\pm V^+$	Volts
Load Current	$I_L$	15	mA
Output Short Circuit Duration	$t_S$	Continuous	
Power Dissipation (Package Limitation) Derate above $25^\circ\text{C}$	$P_D$	680 4.6	mW mW/ $^\circ\text{C}$
Operating Temperature Range	$T_A$	0 to +75	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$

## CIRCUIT SCHEMATIC

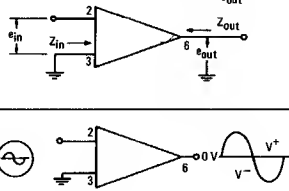
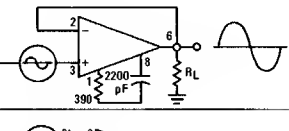
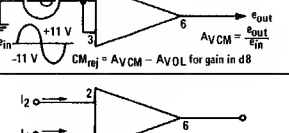
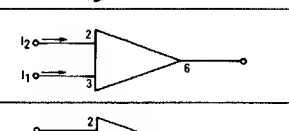
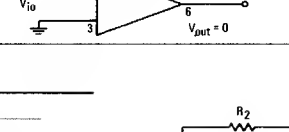
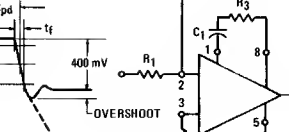
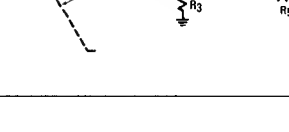

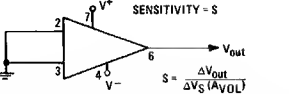
## EQUIVALENT CIRCUIT



\*PATENT PENDING

## MC1439G (continued)

**ELECTRICAL CHARACTERISTICS** ( $V^+ = +15\text{ Vdc}$ ,  $V^- = -15\text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic Definitions (linear operation)	Characteristic	Symbol	Min	Typ	Max	Unit
	Open Loop Voltage Gain $(R_L = 2.0 \text{ k}\Omega, V_{out} = \pm 10 \text{ V}, T_A = 0^\circ\text{C to } +75^\circ\text{C})$	$A_{VOL}$	15,000	100,000	-	-
	Output Impedance ( $f = 20 \text{ Hz}$ )	$Z_{out}$	-	4.0	-	$\text{k}\Omega$
	Input Impedance ( $f = 20 \text{ Hz}$ )	$Z_{in}$	100	300	-	$\text{k}\Omega$
	Output Voltage Swing ( $R_L = 10 \text{ k}\Omega$ ) ( $R_L = 2.0 \text{ k}\Omega$ )	$V_{out}$	$\pm 12$ $\pm 10$	$\pm 14$ $\pm 13$	-	$V_{peak}$
	Power Bandwidth ( $A_v = 1, R_L = 2.0 \text{ k}\Omega$ , $\text{THD} \leq 5\%, V_o = 20 \text{ V p-p}$ )	$P_{BW}$	10	50	-	$\text{kHz}$
	Input Common Mode Voltage Swing	$CMV_{in}$	$\pm 11$	$\pm 12$	-	$V_{peak}$
	Common Mode Rejection Ratio	$CM_{rej}$	80	100	-	$\text{dB}$
	Input Bias Current $I_b = \frac{I_1 + I_2}{2}$ , ( $T_A = +25^\circ\text{C}$ ) ( $T_A = 0^\circ\text{C}$ )	$I_b$	-	0.20 0.23	1.0 1.5	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ ) ( $I_{io} = I_1 - I_2, T_A = 0^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2, T_A = +75^\circ\text{C}$ )	$I_{io}$	-	20 - -	100 150 150	$\text{nA}$
	Input Offset Voltage ( $T_A = 25^\circ\text{C}$ ) ( $T_A = 0^\circ\text{C}, +75^\circ\text{C}$ )	$V_{io}$	-	2.0 -	7.5 10	$\text{mV}$
	Step Response $\left\{ \begin{array}{l} \text{Gain} = 100, \text{ no overshoot,} \\ R_1 = 1.0 \text{ k}\Omega, R_2 = 100 \text{ k}\Omega, R_3 = 1.0 \text{ k}\Omega, \\ R_4 = 10 \text{ k}\Omega, R_5 = 10 \text{ k}\Omega, C_1 = 2200 \text{ pF} \end{array} \right\}$ $\left\{ \begin{array}{l} \text{Gain} = 100, \text{ no overshoot,} \\ R_1 = 1.0 \text{ k}\Omega, R_2 = 10 \text{ k}\Omega, R_3 = 1.0 \text{ k}\Omega, \\ R_4 = 10 \text{ k}\Omega, R_5 = \infty, C_1 = 2200 \text{ pF} \end{array} \right\}$ $\left\{ \begin{array}{l} \text{Gain} = 10, 15\% \text{ overshoot,} \\ R_1 = 1.0 \text{ k}\Omega, R_2 = 10 \text{ k}\Omega, R_3 = 1.0 \text{ k}\Omega, \\ R_4 = 1.0 \text{ k}\Omega, R_5 = 10 \text{ k}\Omega, C_1 = 2200 \text{ pF} \end{array} \right\}$ $\left\{ \begin{array}{l} \text{Gain} = 10, 15\% \text{ overshoot,} \\ R_1 = 1.0 \text{ k}\Omega, R_2 = 10 \text{ k}\Omega, R_3 = 1.0 \text{ k}\Omega, \\ R_4 = 1.0 \text{ k}\Omega, R_5 = \infty, C_1 = 2200 \text{ pF} \end{array} \right\}$ $\left\{ \begin{array}{l} \text{Gain} = 1, 15\% \text{ overshoot,} \\ R_1 = 10 \text{ k}\Omega, R_2 = 10 \text{ k}\Omega, R_3 = 5.0 \text{ k}\Omega, \\ R_4 = 390 \Omega, R_5 = 10 \text{ k}\Omega, C_1 = 2200 \text{ pF} \end{array} \right\}$ $\left\{ \begin{array}{l} \text{Gain} = 1, 15\% \text{ overshoot,} \\ R_1 = 10 \text{ k}\Omega, R_2 = 10 \text{ k}\Omega, R_3 = 5.0 \text{ k}\Omega, \\ R_4 = 390 \Omega, R_5 = \infty, C_1 = 2200 \text{ pF} \end{array} \right\}$	$t_f$ $t_{pd}$ $dV_{out}/dt$ $t_f$ $t_{pd}$ $dV_{out}/dt$ $t_f$ $t_{pd}$ $dV_{out}/dt$ $t_f$ $t_{pd}$ $dV_{out}/dt$ $t_f$ $t_{pd}$ $dV_{out}/dt$ $t_f$ $t_{pd}$ $dV_{out}/dt$	-	700 100 34 700 100 1.7 600 80 6.25 600 80 1.7 400 80 4.2 400 80 1.4	-	ns ns $\text{V}/\mu\text{s}$ ns ns $\text{V}/\mu\text{s}$ ns ns $\text{V}/\mu\text{s}$ ns ns $\text{V}/\mu\text{s}$ ns ns $\text{V}/\mu\text{s}$ ns ns $\text{V}/\mu\text{s}$
	Equivalent Input Noise Voltage (Open Loop) ( $R_S = 10 \text{ k}\Omega$ , Noise Bandwidth = 1.0 Hz, $f = 1.0 \text{ kHz}$ )	$e_n$	-	30	-	$\text{nV}/(\text{Hz})^{1/2}$
	Average Temperature Coefficient of Input Offset Voltage ( $R_S = 50\Omega, T_A = 0^\circ\text{C to } +75^\circ\text{C}$ ) ( $R_S \leq 10 \text{ k}\Omega, T_A = 0^\circ\text{C to } +75^\circ\text{C}$ )	$TC_{V_{io}}$	-	3.0 5.0	-	$\mu\text{V}/^\circ\text{C}$
	DC Power Dissipation (Power Supply = $\pm 15 \text{ V}, V_{out} = 0$ )	$P_D$	-	90	200	$\text{mW}$
	Positive Supply Sensitivity ( $V^-$ constant)	$S^+$	-	50	200	$\mu\text{V}/\text{V}$
	Negative Supply Sensitivity ( $V^+$ constant)	$S^-$	-	50	200	$\mu\text{V}/\text{V}$

\*To improve performance, development is in process to include resistor  $R_5 \approx 10 \text{ k}\Omega$  on the device chip. Available after September, 1968.

# TYPICAL OUTPUT CHARACTERISTICS

( $V^+ = +15$  Vdc,  $V^- = -15$  Vdc,  $T_A = 25^\circ\text{C}$ )

FIGURE NO.	CURVE NO.	VOLTAGE GAIN	TEST CONDITIONS (FIGURE 1)					
			$R_1(\Omega)$	$R_2(\Omega)$	$R_3(\Omega)$	$R_4(\Omega)$	$R_5^*(\Omega)$	$C_1(\text{pF})$
2	1	1.0	10 k	10 k	5.0 k	390	10 k	2200
	2	1.0	10 k	10 k	5.0 k	390	10 k	2200
3	1	$A_{VOL}$	0	$\infty$	0	$\infty$	$\infty$	0
	2	1000	1000	1.0 M	1000	0	$\infty$	10
	3	100	1000	100 k	1000	10 k	$\infty$	2200
	4	10	1000	10 k	1000	1.0 k	$\infty$	2200
	5	1.0	10 k	10 k	5.0 k	390	$\infty$	2200
4	1	$A_{VOL}$	0	$\infty$	0	$\infty$	$\infty$	0
	2	$A_{VOL}$	0	8	0	10 k	$\infty$	2200
	3	$A_{VOL}$	0	$\infty$	0	390	$\infty$	2200

\*To improve performance, development is in process to include resistor  $R_5 \approx 10$  k $\Omega$  on the device chip.  
Available after September 1968.

FIGURE 1 – TEST CIRCUIT

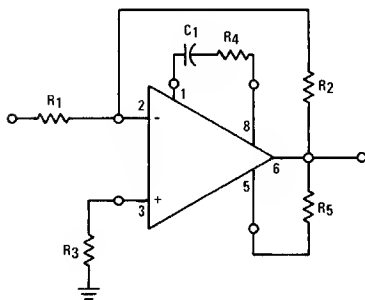


FIGURE 2 – POWER BANDWIDTH  
(LARGE SIGNAL SWING versus FREQUENCY)

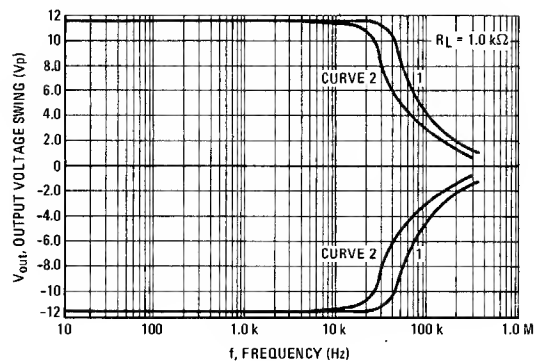


FIGURE 3 – VOLTAGE GAIN versus FREQUENCY

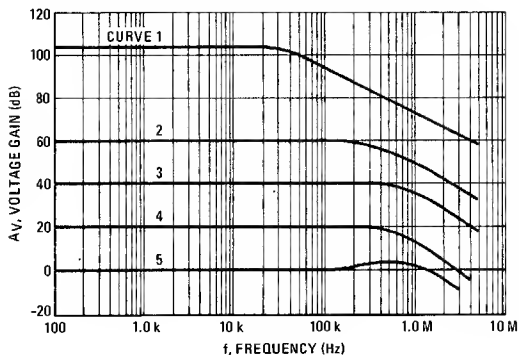
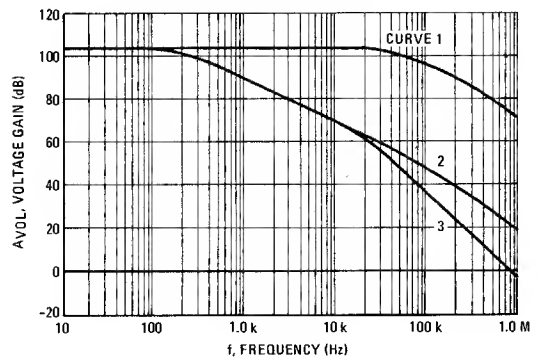
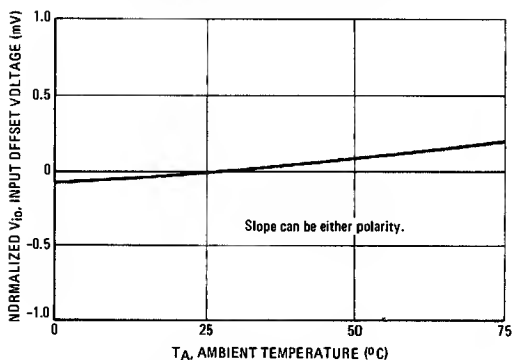


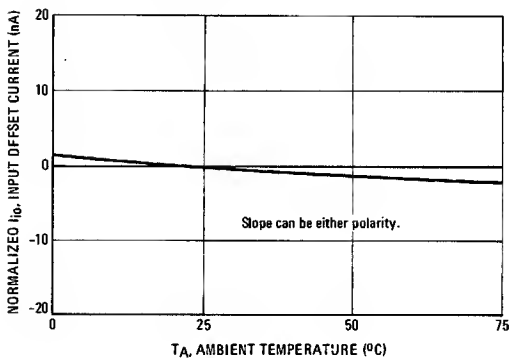
FIGURE 4 – OPEN LOOP VOLTAGE GAIN  
versus FREQUENCY



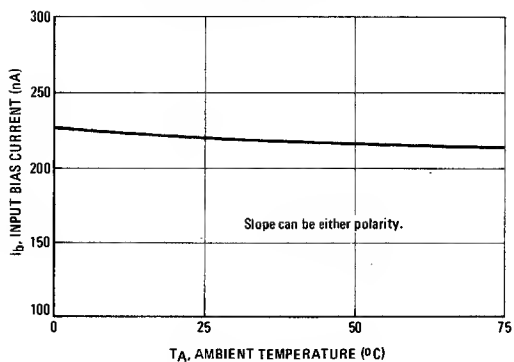
**FIGURE 5 – INPUT OFFSET VOLTAGE  
versus TEMPERATURE**



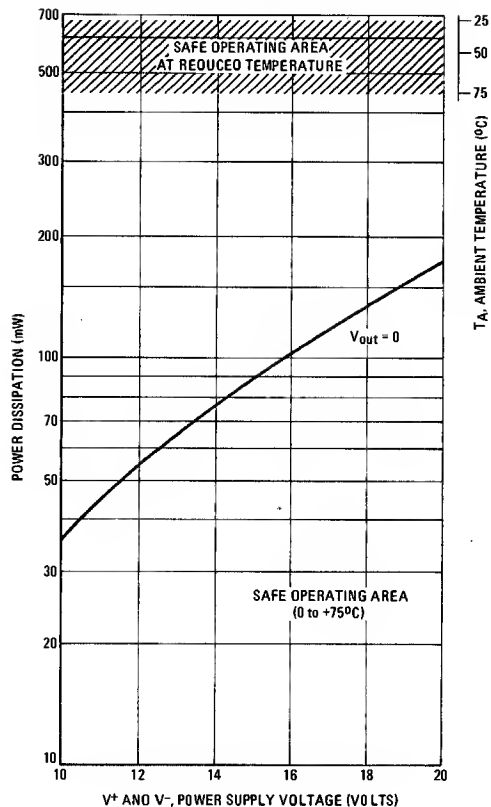
**FIGURE 6 – INPUT OFFSET CURRENT  
versus TEMPERATURE**



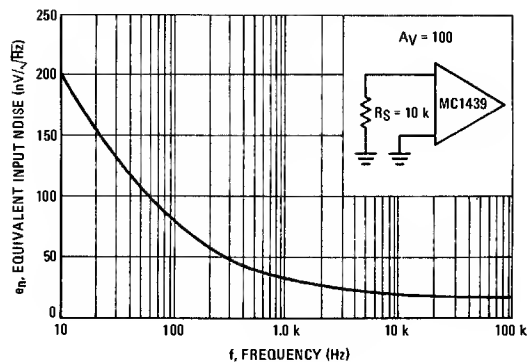
**FIGURE 8 – INPUT BIAS CURRENT  
versus TEMPERATURE**



**FIGURE 7 – POWER DISSIPATION  
versus POWER SUPPLY VOLTAGE**



**FIGURE 9 – SPECTRAL NOISE DENSITY**





# OPERATIONAL AMPLIFIER

# OPERATIONAL AMPLIFIERS

## MC1520

... designed for use in general-purpose or wide band differential amplifier applications, especially those requiring differential outputs.



Lead 3 connected to case

CASE 71A  
"G" SUFFIX



CASE 72  
(TO-91)  
"F" SUFFIX

### Typical Characteristics:

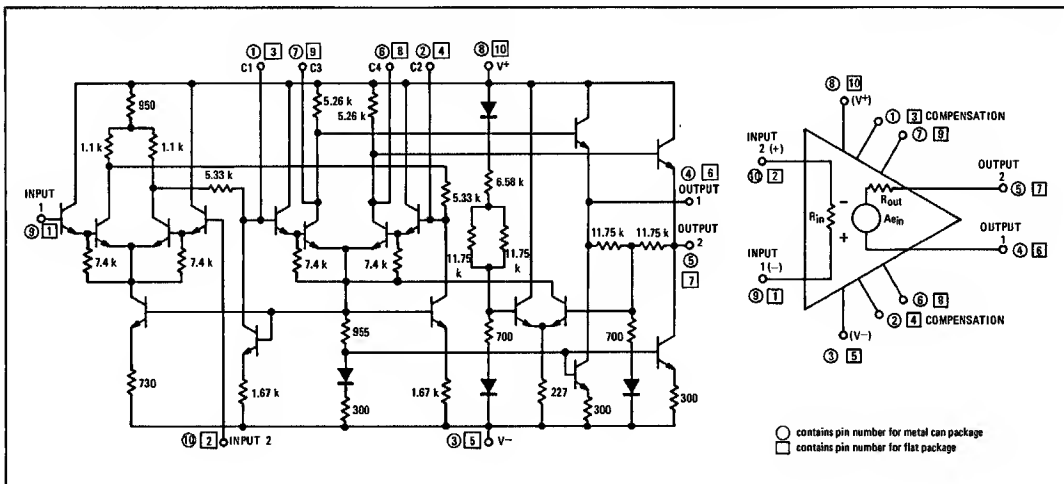
- Differential Input and Differential Output
- Wide Closed-Loop Bandwidth; 10 MHz
- Differential Gain; 70 dB
- High Input Impedance; 2.0 megohms
- Low Output Impedance; 50 ohms

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+8.0 -8.0	Vdc
Differential Input Signal	$V_{in}$	$\pm 8.0$	Vdc
Load Current	$I_{L1}, I_{L2}$	15	mA
Power Dissipation (Package Limitation)	$P_D$		
Metal Can Derate above $25^\circ\text{C}$		680	mW
Flat Package Derate above $25^\circ\text{C}$		4.6	mW/ $^\circ\text{C}$
		500	mW
		3.3	mW/ $^\circ\text{C}$
Operating Temperature Range	$T_A$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$

FIGURE 1 – CIRCUIT SCHEMATIC

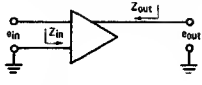

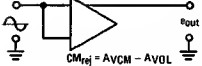
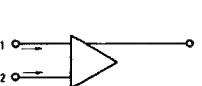

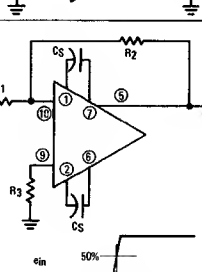
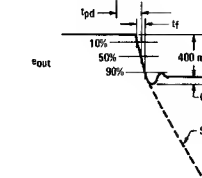
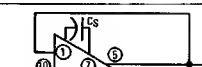
FIGURE 2 – EQUIVALENT CIRCUIT



# MC1520 (continued)

## SINGLE-ENDED ELECTRICAL CHARACTERISTICS

( $V^+ = +6.0$  Vdc,  $V^- = -6.0$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic Definitions ①	Characteristic	Symbol	Min	Typ	Max	Unit
	Open Loop Voltage Gain ( $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ )	$A_{VOL}$	1000 60	1500 64	2500 68	V/V dB
	Output Impedance ( $f = 20$ Hz)	$Z_{out}$	-	50	100	ohms
	Input Impedance ( $f = 20$ Hz)	$Z_{in}$	0.5	2.0	-	megohms
	Output Voltage Swing $R_L = 7.0$ k $\Omega$ (Figure 8)	$V_{out}$	$\pm 3.5$	$\pm 4.0$	-	V <sub>peak</sub>
	Input Common Mode Voltage Swing	$CMV_{in}$	$\pm 2.0$	$\pm 3.0$	-	V <sub>peak</sub>
	Common Mode Rejection Ratio	$CM_{rej}$	75	90	-	dB
	Input Bias Current ( $I_b = \frac{I_1 + I_2}{2}$ ), $T_A = -25^\circ\text{C}$	$I_b$	-	0.8	2.0	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ ) ( $I_{io} = I_1 - I_2$ , $T_A = -55^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2$ , $T_A = +125^\circ\text{C}$ )	$I_{io}$	-	30 - -	100 200 200	nA
	Input Offset Voltage $T_A = 25^\circ\text{C}$	$V_{io}$	-	5.0	10	mV
	Step Response Gain = 1.0, 10% Overshoot $R_1 = 10$ k $\Omega$ $R_2 = 10$ k $\Omega$ $R_3 = 5.0$ k $\Omega$ $C_s = 39$ pF Gain = 10, 10% Overshoot $R_1 = 10$ k $\Omega$ $R_2 = 100$ k $\Omega$ $R_3 = 10$ k $\Omega$ $C_s = 10$ pF Gain = 100, No Overshoot $R_1 = 1.0$ k $\Omega$ $R_2 = 100$ k $\Omega$ $R_3 = 1.0$ k $\Omega$ $C_s = 1.0$ pF Open Loop, No Overshoot $R_1 = 50$ $\Omega$ $R_2 = \infty$ $R_3 = 50$ $\Omega$ $C_s = 0$	$t_f$ $t_{pd}$ $\frac{dV_{out}}{dt}$ ②	-	80 70 5.0	-	ns ns V/ $\mu\text{s}$
	Bandwidth: Open Loop (Figure 4) Closed Loop (Unity Gain) (Figure 5)	-	-	2.0 10	-	MHz
	Input Noise Voltage (Open Loop) (5.0 Hz - 5.0 MHz)	$V_{n(in)}$	-	11	15	$\mu\text{V(rms)}$
	Average Temperature Coefficient of Input Offset Voltage ( $R_S = 50$ $\Omega$ , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$TCV_{io}$	-	2.0	-	$\mu\text{V}/^\circ\text{C}$
	DC Power Dissipation $V_{out} = 0$	$P_D$	-	120	240	mW
	Power Supply Sensitivity ( $V \neq \text{Constant}$ )	$S^\pm$	-	250	450	$\mu\text{V/V}$

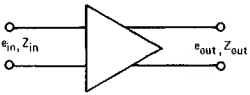
① All definitions imply linear operation.

②  $\frac{dV_{out}}{dt}$  = Slew Rate

# MC1520 (continued)

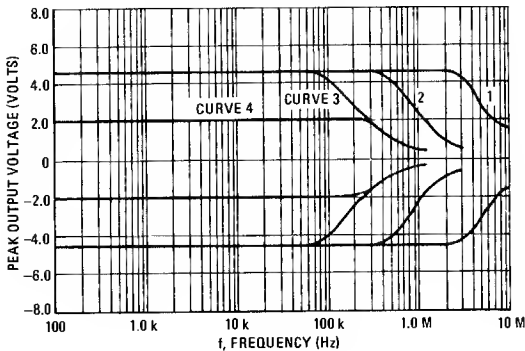
## DIFFERENTIAL ELECTRICAL CHARACTERISTICS

( $V^+ = +6.0$  Vdc,  $V^- = -6.0$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

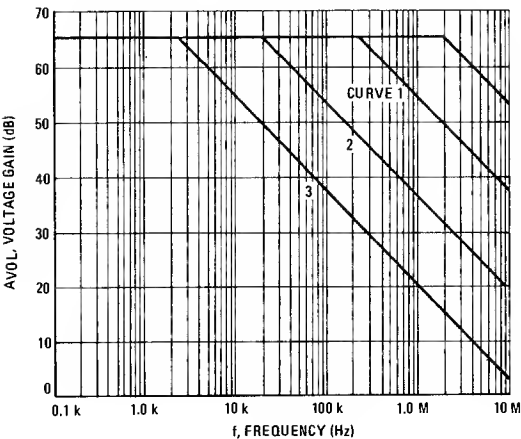
Characteristic Definitions	Characteristic	Symbol	Min	Typ	Max	Unit
	Gain (Open Loop)	$A_{VOL}$	2000 66	3000 70	5000 74	-
	Input Impedance ( $f = 20$ Hz)	$Z_{in}$	0.5	2.0	-	megohms
	Output Impedance ( $f = 20$ Hz)	$Z_{out}$	-	100	200	ohms
	Common Mode Output Voltage	$V_{out(CM)}$	-0.5	0	+0.5	Vdc
	Output Voltage Swing $R_L = 7.0$ k $\Omega$	$V_{out}$	$\pm 7.0$	$\pm 8.0$	-	V <sub>peak</sub>

## TYPICAL OUTPUT CHARACTERISTICS ( $V^+ = +6.0$ Vdc, $V^- = -6.0$ Vdc, unless otherwise noted)

**FIGURE 3 - LARGE SIGNAL SWING versus FREQUENCY**



**FIGURE 4 - OPEN LOOP VOLTAGE GAIN**



**TEST CIRCUIT**

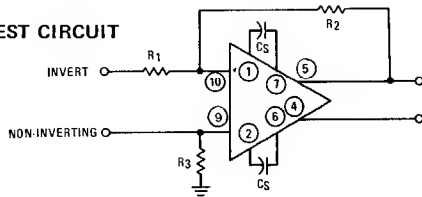
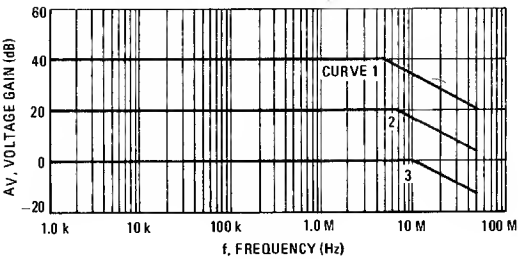


FIGURE NO	CURVE NO	MODE	VOLTAGE GAIN	TEST CONDITIONS				NOISE OUTPUT mV <sub>rms</sub>
				$R_1$ ( $\Omega$ )	$R_2$ ( $\Omega$ )	$R_3$ ( $\Omega$ )	$C_S$ (pF)	
3	1	INVERTING	100	1.0 k	100 k	1.0 k	1.0	2.0
	2	INVERTING	10	10 k	100 k	10 k	10	0.55
	3	INVERTING	1.0	10 k	10 k	5.0 k	39	0.17
	4	NON INVERTING	1.0	$\infty$	10 k	10 k	39	0.17
4	1	NON INVERTING	$A_{VOL}$	0	$\infty$	50	1.0	1.0
	2	NON INVERTING	$A_{VOL}$	0	$\infty$	50	10	2.0
	3	NON INVERTING	$A_{VOL}$	0	$\infty$	50	39	5.2
5	1	NON INVERTING	100	100	10 k	100	1.0	2.0
	2	NON INVERTING	10	1.0 k	9.1 k	910	10	0.55
	3	NON INVERTING	1.0	$\infty$	10 k	10 k	39	0.17

**FIGURE 5 - CLOSED LOOP VOLTAGE GAIN versus FREQUENCY**



TYPICAL CHARACTERISTICS

FIGURE 6 - POWER DISSIPATION  
versus POWER SUPPLY VOLTAGE

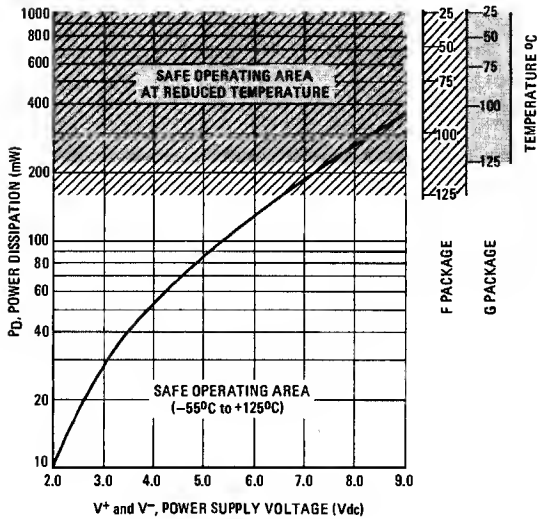


FIGURE 7 - OPEN LOOP VOLTAGE GAIN  
versus SUPPLY VOLTAGE

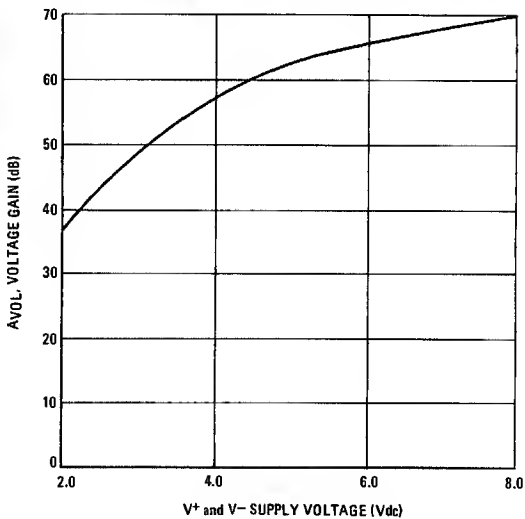


FIGURE 8 - SINGLE ENDED OUTPUT VOLTAGE  
versus LOAD RESISTANCE

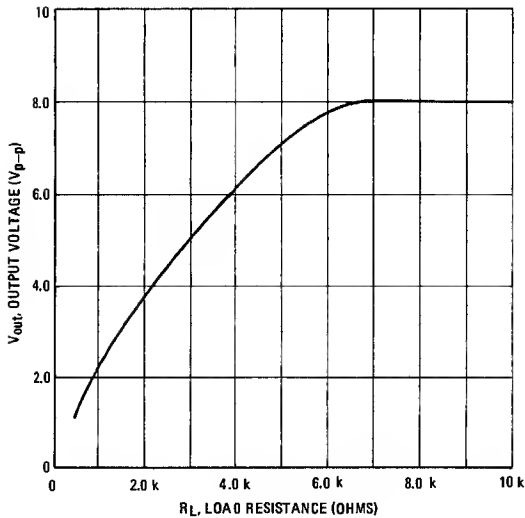
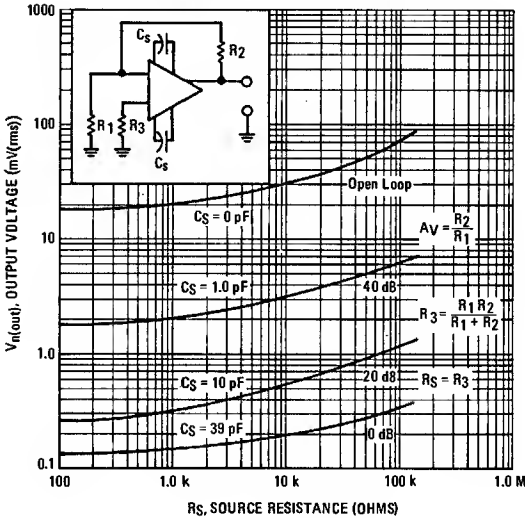


FIGURE 9 - OUTPUT NOISE VOLTAGE  
versus SOURCE RESISTANCE



## OPERATIONAL AMPLIFIER

## OPERATIONAL AMPLIFIERS

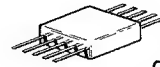
### MC1530 MC1531

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.

Lead 4 connected to case



CASE 71  
"G" SUFFIX



CASE 72  
(TO-91)  
"F" SUFFIX

#### Typical Amplifier Features:

- Excellent Open Loop Gain Characteristics  
 $AVOL = 74 \text{ dB typical}$   
 $AVOL \text{ stability} = \pm 1.5 \text{ dB from } -55^\circ\text{C to } +125^\circ\text{C}$
- Low Temperature Drift —  $\pm 3.0 \mu\text{V}/^\circ\text{C}$
- Large Output Voltage Swing —  
 Typically  $\pm 5.0 \text{ V}$  @  $\pm 6.0 \text{ V}$  Supply
- Low Output Impedance —  
 $Z_{out} = 25 \text{ ohms typical}$
- High Slew Rate — typically  $4.5 \text{ V}/\mu\text{s}$   
 @  $AV = 10$

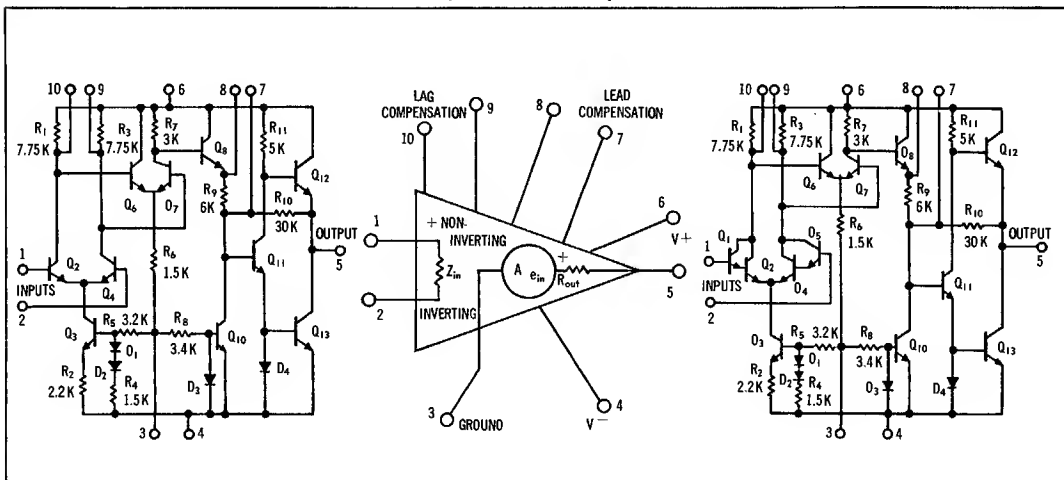
#### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	V+	+9.0	Vdc
Power Supply Voltage	V-	-9.0	Vdc
Differential Input Signal	$V_{in}$	$\pm 5.0$	Vdc
Load Current	$I_L$	10	mA
Power Dissipation (Package Limitation)	$P_D$		
Metal Can Derate above $25^\circ\text{C}$		680 4.6	mW $\text{mW}/^\circ\text{C}$
Flat Package Derate above $25^\circ\text{C}$		500 3.3	mW $\text{mW}/^\circ\text{C}$
Operating Temperature Range	$T_A$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +175	$^\circ\text{C}$

#### MC1530 (STANDARD INPUT)

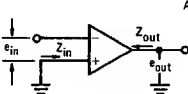
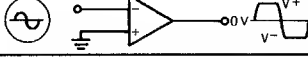
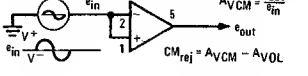
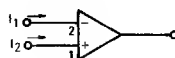
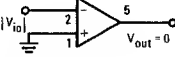
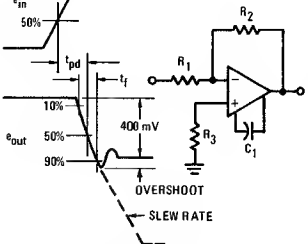
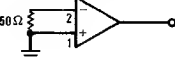

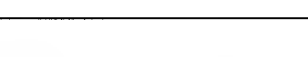
#### EQUIVALENT CIRCUIT (BOTH TYPES)

#### MC1531 (DARLINGTON INPUT)



# MC1530, MC1531 (continued)

## ELECTRICAL CHARACTERISTICS (V<sup>+</sup> = +6.0Vdc, V<sup>-</sup> = -6.0Vdc, T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic Definitions (linear operations)	Characteristic	Symbol	Min	Typ	Max	Unit
 $A_{VOL} = \frac{e_{out}}{e_{in}}$	Open Loop Voltage Gain (T <sub>A</sub> = -55 to +125°C)	MC1530 MC1531	4500 2500	5000 3500	12500 7000	V/V dB
	Output Impedance (f = 20 Hz)	MC1530 MC1531	-	25	50	ohms
	Input Impedance (f = 20 Hz)	MC1530 MC1531	10 k 1.0 M	20 k 2.0 M	-	ohms
	Output Voltage Swing (R <sub>L</sub> = 1.0 k ohm)	MC1530 MC1531	±4.5	±5.2	-	V <sub>peak</sub>
 $A_{VCM} = \frac{e_{out}}{e_{in}}$	Input Common Mode Voltage Swing	MC1530 MC1531	±2.0 ±2.0	±2.7 ±2.4	-	V <sub>peak</sub>
	Common Mode Rejection Ratio	MC1530 MC1531	70 65	75 65	-	dB
 $I_b = \frac{I_1 + I_2}{2}$	Input Bias Current	MC1530 MC1531	- -	3.0 0.025	10 0.150	μA
	Input Offset Current	MC1530 MC1531	- -	0.200 0.003	2.0 0.025	μA
 $V_{io}$	Input Offset Voltage	MC1530 MC1531	- -	1.0 3.0	5.0 10	mV
	Step Response (Gain = 100, 0% overshoot R <sub>1</sub> = 1.0 k ohm R <sub>2</sub> = 100 k ohm R <sub>3</sub> = 1.0 k ohm C <sub>1</sub> = 1800 pF)	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	- - -	0.60 0.30 17	- - -	μs μs V/μs
	(Gain = 10, 10% overshoot R <sub>1</sub> = 10 k ohm R <sub>2</sub> = 100 k ohm R <sub>3</sub> = 10 k ohm C <sub>1</sub> = 6800 pF)	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	- - -	0.24 0.18 4.5	- - -	μs μs V/μs
	(Gain = 1.0, 5.0% overshoot R <sub>1</sub> = 10 k ohm R <sub>2</sub> = 10 k ohm R <sub>3</sub> = 5.0 k ohm C <sub>1</sub> = 33,000 pF)	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	- - -	0.20 0.16 1.0	- - -	μs μs V/μs
	Input Noise Voltage (Open Loop, 50 ohm source, BW <sub>OL</sub> = 5.0 MHz)	MC1530 MC1531	- -	10 20	-	μV <sub>rms</sub>
	Average Temperature Coefficient of Input Offset Voltage 25°C to +125°C	MC1530	-	3.8	-	μV/°C
	-55°C to +25°C	MC1531	-	8.0	-	μV/°C
 $P_D$	25°C to +125°C	MC1531	-	11	-	μV/°C
	-55°C to +25°C	MC1531	-	20	-	μV/°C
 $S^+$	D. C. Power Dissipation (Power Supply = ±6.0 V, V <sub>out</sub> = 0)	MC1530 MC1531	-	110	150	mW
	Positive Supply Sensitivity (V <sup>-</sup> constant)	MC1530 MC1531	-	100	-	μV/V
 $S^-$	Negative Supply Sensitivity (V <sup>+</sup> constant)	MC1530 MC1531	-	100	-	μV/V

①  $dV_{out}/dt$  = Slew Rate

# TYPICAL OUTPUT CHARACTERISTICS

$V^+ = +6.0 \text{ Vdc}$ ,  $V^- = -6.0 \text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$

FIGURE 1 – TEST CIRCUIT

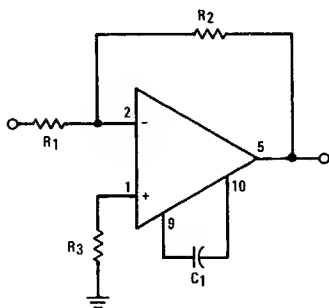


FIG. NO.	CURVE NO.	VOLTAGE GAIN	DEVICE	TEST CONDITIONS				OUTPUT NOISE (mV rms)
				$R_1 (\Omega)$	$R_2 (\Omega)$	$R_3 (\Omega)$	$C_1 (\mu\text{F})$	
2	1	100	MC1530	1.0 k	100 k	1.0 k	1800	3.5
		100	MC1531	1.0 k	100 k	1.0 k	1800	3.4
	2	10	MC1530	10 k	100 k	10 k	6800	4.8
		10	MC1531	10 k	100 k	10 k	6800	4.8
	3	1.0	MC1530	10 k	10 k	5.0 k	33000	3.4
		1.0	MC1531	10 k	10 k	5.0 k	33000	7.0
3	1	100	MC1530	1.0 k	100 k	1.0 k	1800	3.5
		100	MC1531	1.0 k	100 k	1.0 k	1800	3.4
	2	10	MC1530	10 k	100 k	10 k	6800	4.8
		10	MC1531	10 k	100 k	10 k	6800	4.8
	3	1.0	MC1530	10 k	10 k	5.0 k	33000	3.4
		1.0	MC1531	10 k	10 k	5.0 k	33000	7.0
4	1	AVOL	MC1530	0	$\infty$	0	1800	7.6
		AVOL	MC1531	0	$\infty$	0	1800	19.0
	2	AVOL	MC1530	0	$\infty$	0	6800	5.5
		AVOL	MC1531	0	$\infty$	0	6800	15.0
	3	VVOL	MC1530	0	$\infty$	0	33000	5.0
		AVOL	MC1531	0	$\infty$	0	33000	11.0

FIGURE 2 – LARGE SIGNAL SWING versus FREQUENCY

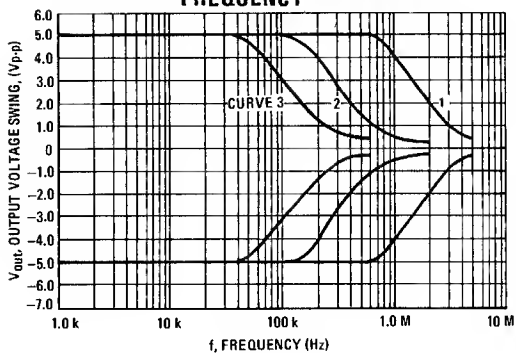


FIGURE 3 – VOLTAGE GAIN versus FREQUENCY

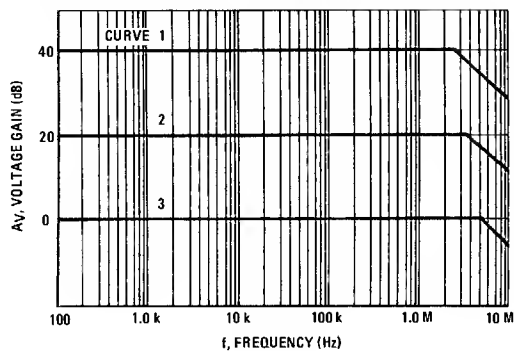


FIGURE 4 – OPEN LOOP VOLTAGE GAIN versus FREQUENCY

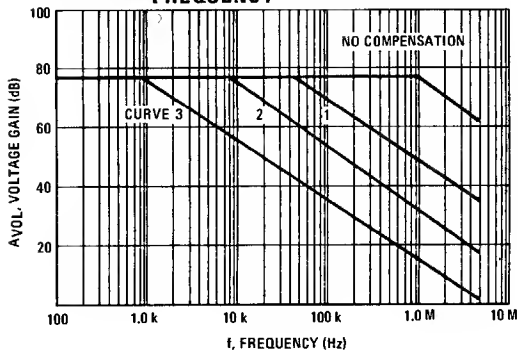
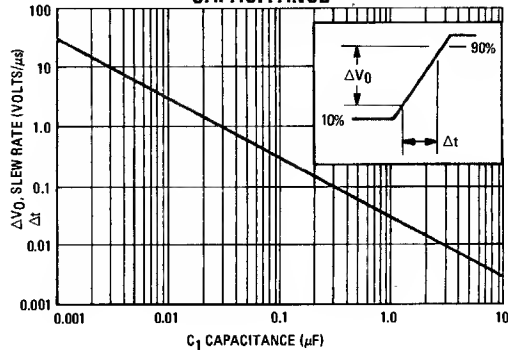
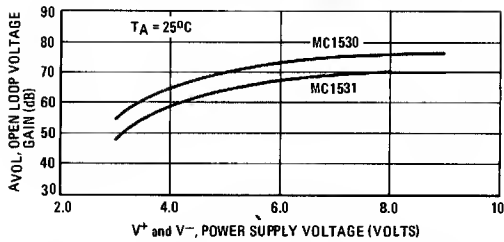


FIGURE 5 – SLEW RATE versus ROLLOFF CAPACITANCE

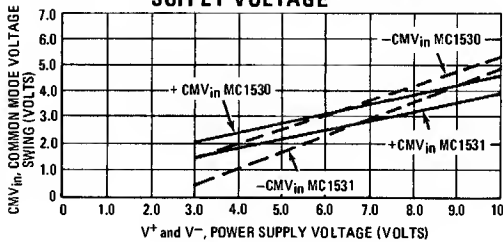


## MC1530, MC1531 (continued)

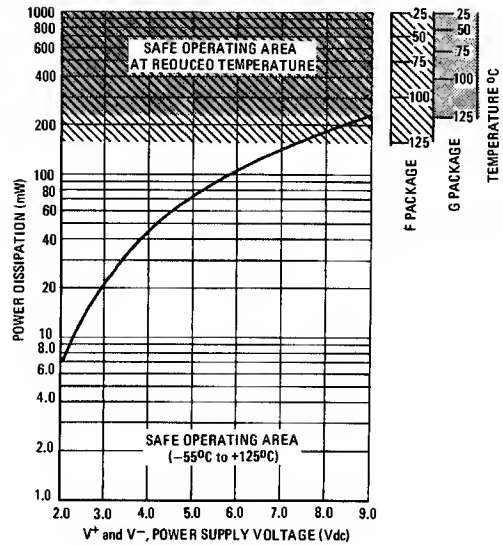
**FIGURE 6 – VOLTAGE GAIN versus POWER SUPPLY VOLTAGE**



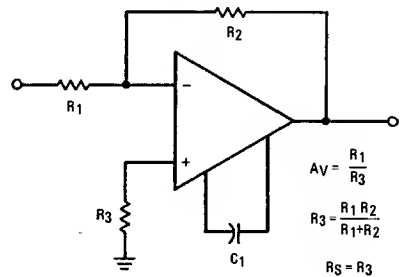
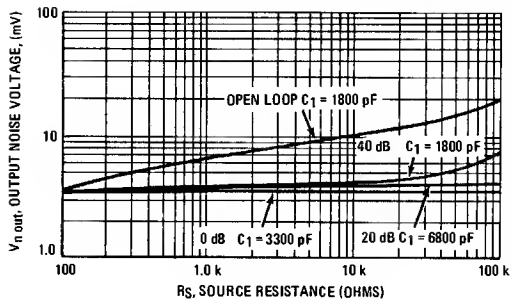
**FIGURE 7 – COMMON MODE SWING versus POWER SUPPLY VOLTAGE**



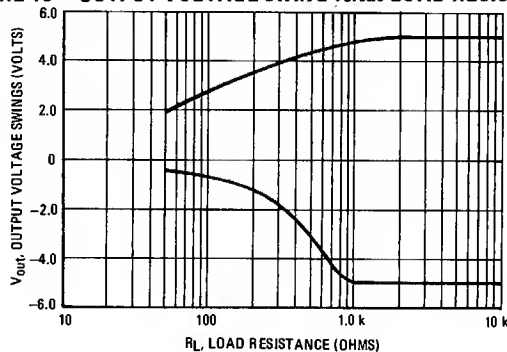
**FIGURE 8 – POWER DISSIPATION versus POWER SUPPLY VOLTAGE**



**FIGURE 9 – OUTPUT NOISE VOLTAGE versus SOURCE RESISTANCE**



**FIGURE 10 – OUTPUT VOLTAGE SWING versus LOAD RESISTANCE**





# OPERATIONAL AMPLIFIER

# OPERATIONAL AMPLIFIERS

## MC1533

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.



Lead 4 connected to case  
CASE 71  
"G" SUFFIX



CASE 72  
(TO-91)  
"F" SUFFIX

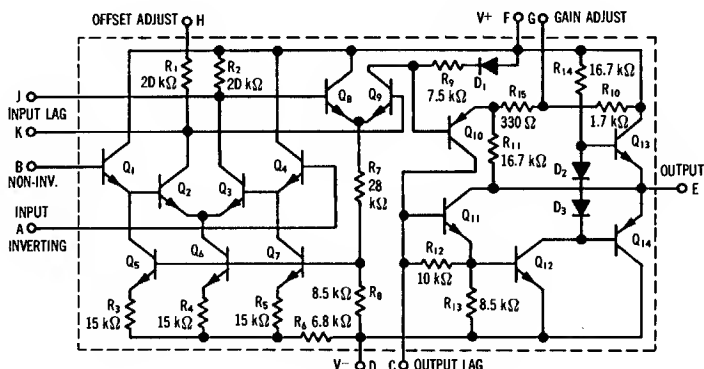
### Typical Amplifier Features:

- High-Performance Open Loop Gain Characteristics  
 $A_{VOL} = 60,000$  typical
- Low Temperature Drift —  $\pm 5.0 \mu V/^{\circ}C$
- Large Output Voltage Swing —  
 $\pm 13 V$  Typical @  $\pm 15 V$  Supply
- Low Output Impedance —  
 $Z_{out} = 100$  ohms typical
- Input Offset Voltage Adjustable to Zero

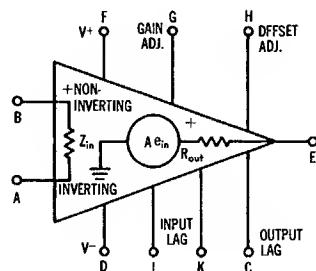
### MAXIMUM RATINGS ( $T_A = 25^{\circ}C$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+20 -20	Vdc Vdc
Differential Input Signal	$V_{in}$	$\pm 10$	Volts
Common Mode Input Swing	$CMV_{in}$	$\pm V^+$	Volts
Load Current	$I_L$	10	mA
Output Short Circuit Duration	$t_s$	1.0	s
Power Dissipation (Package Limitation)	$P_D$		
Metal Can		680	mW
Derate above $T_A = 25^{\circ}C$		4.6	mW/ $^{\circ}C$
Flat Package		500	mW
Derate above $T_A = 25^{\circ}C$		3.3	mW/ $^{\circ}C$
Operating Temperature Range	$T_A$	-55 to +125	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^{\circ}C$

### CIRCUIT SCHEMATIC



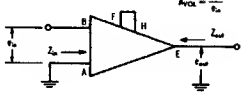
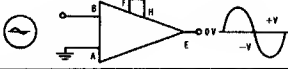
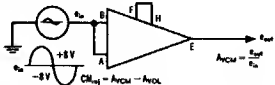
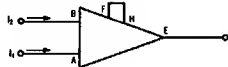
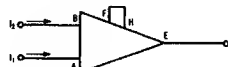
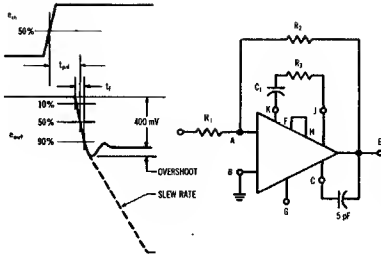
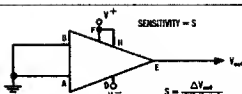
### EQUIVALENT CIRCUIT



### PIN CONNECTIONS

Schematic	A	B	C	D	E	F	G	H	J	K
"G" Package	1	2	3	4	5	6	7	8	9	10
"F" Package	10	1	2	3	4	5	6	7	8	9

ELECTRICAL CHARACTERISTICS ( $V^+ = +15$  Vdc,  $V^- = -15$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic Definitions <sup>①</sup>	Characteristic	Symbol	Min	Typ	Max	Unit
 $A_{VOL} = \frac{V_{out}}{V_{in}}$	Open Loop Voltage Gain (V @ Pin G = +15 Vdc) (Pin G open) (V @ Pin G = +15 Vdc, $T_A = -55^\circ\text{C}$ , $+125^\circ\text{C}$ ) (Pin G open, $T_A = -55^\circ\text{C}$ , $+125^\circ\text{C}$ )	$A_{VOL}$	40,000 15,000 35,000 12,000	60,000 30,000 50,000 25,000	150,000 60,000 150,000 60,000	-
	Output Impedance (Pin G open, $f = 20$ Hz)	$Z_{out}$	-	100	150	$\Omega$
	Input Impedance (Pin G open, $f = 20$ Hz)	$Z_{in}$	500	1000	-	k $\Omega$
	Output Voltage Swing ( $R_L = 10$ k $\Omega$ ) ( $R_L = 2$ k $\Omega$ )	$V_{out}$	$\pm 12$ $\pm 11$	$\pm 13$ $\pm 12$	- -	V <sub>peak</sub>
 $CM_{rej} = A_{VOL} - A_{VOL}$	Input Common Mode Voltage Swing	$CMV_{in}$	+9 -8	+10 -9	- -	V <sub>peak</sub>
	Common Mode Rejection Ratio (V @ Pin G = +15 Vdc) (Pin G open)	$CM_{rej}$	90 80	100 94	- -	dB
	Input Bias Current $\left( I_b = \frac{I_1 + I_2}{2} \right)$ ( $T_A = +25^\circ\text{C}$ ) $\left( I_b = \frac{I_1 + I_2}{2} \right)$ ( $T_A = -55^\circ\text{C}$ )	$I_b$	- -	0.5 -	1.0 3.0	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ ) ( $I_{io} = I_1 - I_2$ , $T_A = -55^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2$ , $T_A = +125^\circ\text{C}$ )	$I_{io}$	- - -	0.03 - -	0.15 0.5 0.2	$\mu\text{A}$
	Input Offset Voltage <sup>②</sup> ( $T_A = 25^\circ\text{C}$ ) ( $T_A = -55^\circ\text{C}$ , $+125^\circ\text{C}$ )	$V_{io}$	- -	1.0 -	5.0 6.0	mV
	Step Response (Gain = 100, 15% overshoot, $R_1 = 1$ k $\Omega$ , $R_2 = 100$ k $\Omega$ , $R_3 = 100$ $\Omega$ , $C_1 = 0.002$ $\mu\text{F}$ ) (Gain = 10, no overshoot, $R_1 = 1$ k $\Omega$ , $R_2 = 10$ k $\Omega$ , $R_3 = 10$ $\Omega$ , $C_1 = 0.05$ $\mu\text{F}$ ) (Gain = 1, 20% overshoot, $R_1 = 10$ k $\Omega$ , $R_2 = 10$ k $\Omega$ , $R_3 = 5$ $\Omega$ , $C_1 = 0.1$ $\mu\text{F}$ )	$t_f$ $t_{pd}$ $dV_{out}/dt$ ③ $t_f$ $t_{pd}$ $dV_{out}/dt$ ③ $t_f$ $t_{pd}$ $dV_{out}/dt$ ③	- - - - - - - - -	0.15 0.06 11.0 0.3 0.1 1.5 0.2 0.3 0.8	- - - - - - - - -	$\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$ $\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$ $\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$
	Average Temperature Coefficient of Input Offset Voltage ( $T_A = -55^\circ\text{C}$ to $+25^\circ\text{C}$ ) ( $T_A = +25^\circ\text{C}$ to $+125^\circ\text{C}$ )	$TC_{Vio}$	- -	8.0 5.0	- -	$\mu\text{V}/^\circ\text{C}$
	Average Temperature Coefficient of Input Offset Current ( $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ ) ( $T_A = +25^\circ\text{C}$ to $+125^\circ\text{C}$ )	$TC_{Iio}$	- -	0.1 0.05	- -	nA/ $^\circ\text{C}$
	DC Power Dissipation (Power Supply = $\pm 15$ V, $V_{out} = 0$ )	$P_D$	-	120	170	mW
	Positive Supply Sensitivity ( $V^-$ constant)	$S^+$	-	50	150	$\mu\text{V}/\text{V}$
	Negative Supply Sensitivity ( $V^+$ constant)	$S^-$	-	50	150	$\mu\text{V}/\text{V}$

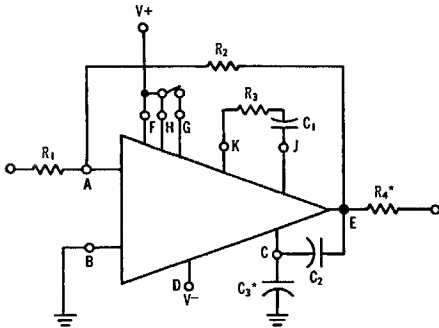
① All definitions imply linear operation

② Input offset voltage ( $V_{io}$ ) may be adjusted to zero by varying the potential on pin H③  $dV_{out}/dt$  = Slew Rate

TYPICAL OUTPUT CHARACTERISTICS

FIGURE 1 — TEST CIRCUIT

$V^+ = +15$  Vdc,  $V^- = -15$  Vdc,  $T_A = 25^\circ\text{C}$



\*FOR CAPACITIVE LOADS,  $R_4 = 47\ \Omega$  OR  $C_2 = 47\ \text{pF}$

Fig. No.	Curve No.	Test Conditions					
		$R_1(\Omega)$	$R_2(\Omega)$	$R_3(\Omega)$	$C_1$	$C_2(\text{pF})$	$C_3(\text{pF})$
2	1	10k	10k	5	1 $\mu\text{F}$	10	47
	2	10k	100k	10	0.1 $\mu\text{F}$	10	47
	3	1k	1M	510	820 pF	10	47
	3	10k	1M	100	0.05 $\mu\text{F}$	10	47
	4	1k	1M	100	0.05 $\mu\text{F}$	3	47
3	4	1k	1M	510	820 pF	3	47
	1 (Low Gain)	1k	1M	10	1000 pF	10	47
	1 (High Gain)	1k	1M	510	820 pF	10	47
	2 (Low Gain)	10k	1M	10	0.01 $\mu\text{F}$	10	47
	2 (High Gain)	10k	1M	100	0.01 $\mu\text{F}$	10	47
	3 (Low Gain)	10k	100k	10	0.1 $\mu\text{F}$	10	47
	3 (High Gain)	10k	100k	10	0.1 $\mu\text{F}$	10	47
	4 (Low Gain)	10k	10k	10	1 $\mu\text{F}$	10	47
4	4 (High Gain)	10k	10k	5	1 $\mu\text{F}$	10	47
	1	0	$\infty$	10	1 $\mu\text{F}$	10	47
	2	0	$\infty$	10	0.1 $\mu\text{F}$	10	47
	3	0	$\infty$	10	0.01 $\mu\text{F}$	10	47
	4	0	$\infty$	10	1000 pF	10	47
5	5	0	$\infty$	10	100 pF	10	47
	1	0	$\infty$	10	1 $\mu\text{F}$	10	47
	2	0	$\infty$	10	0.1 $\mu\text{F}$	10	47
	3	0	$\infty$	10	0.01 $\mu\text{F}$	10	47
	4	0	$\infty$	10	1000 pF	10	47
5	5	0	$\infty$	10	100 pF	10	47

FIGURE 2 — LARGE-SIGNAL SWING versus FREQUENCY

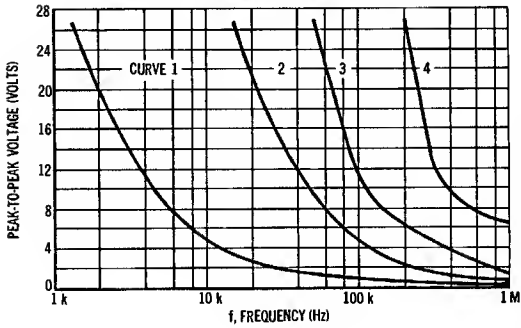


FIGURE 3 — VOLTAGE GAIN versus FREQUENCY

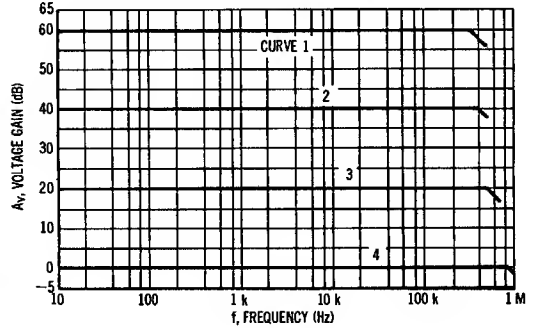


FIGURE 4 — OPEN LOOP VOLTAGE GAIN versus FREQUENCY  
(LOW GAIN CONFIGURATION)

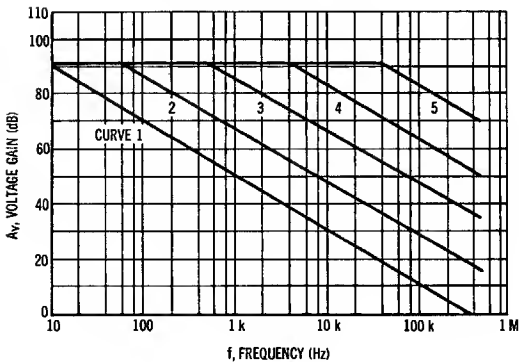
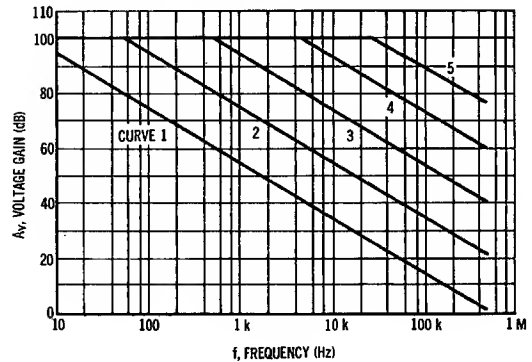


FIGURE 5 — OPEN LOOP VOLTAGE GAIN versus FREQUENCY  
(HIGH GAIN CONFIGURATION)



## TYPICAL CHARACTERISTICS

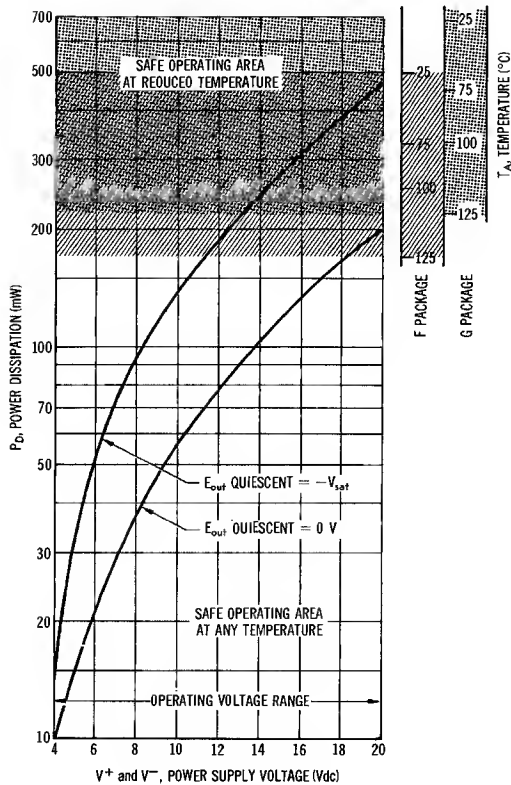
FIGURE 6 — POWER DISSIPATION  
versus POWER SUPPLY VOLTAGE

FIGURE 7 — VOLTAGE GAIN versus POWER SUPPLY VOLTAGE

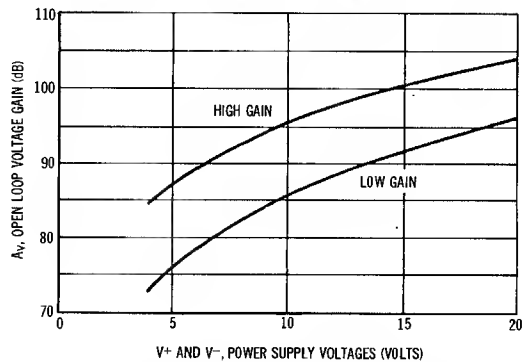


FIGURE 8 — COMMON MODE SWING versus POWER SUPPLY VOLTAGE

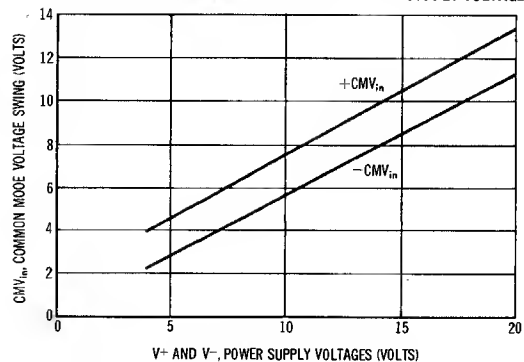


FIGURE 9 — INPUT OFFSET VOLTAGE versus TEMPERATURE

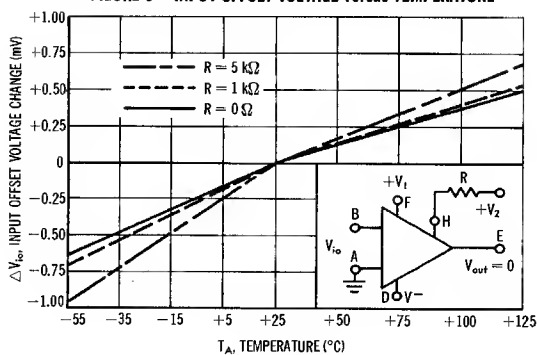
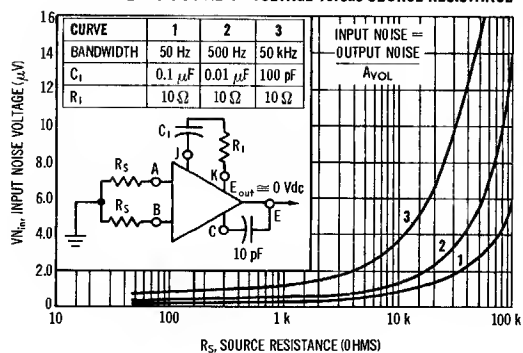


FIGURE 1D — INPUT NOISE VOLTAGE versus SOURCE RESISTANCE



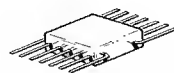
## MC1535

... designed for use as summing amplifiers, integrators, or amplifiers with operating characteristics as a function of the external feedback components. Ideal for chopper stabilized applications where extremely high gain is required with excellent stability.



Lead 1 connected to case

CASE 71  
"G" SUFFIX



CASE 83  
(TO-86)  
"F" SUFFIX

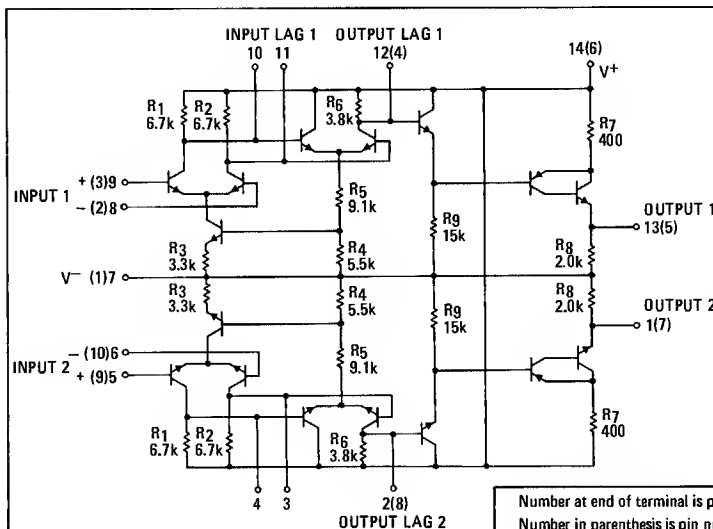
### Typical Amplifier Features:

- High Open Loop Gain Characteristics —  $AV_{OL} = 7,000$  typical
- Low Temperature Drift —  $\pm 10 \mu V/^{\circ}C$
- Large Output Voltage Swing —  $\pm 3.6 V$  Typ @  $\pm 6.0 V$  supply
- Low Input Offset Voltage —  $1.0 mV$
- Low Input Noise Voltage —  $0.5 \mu V$

### MAXIMUM RATINGS ( $T_A = 25^{\circ}C$ unless otherwise noted)

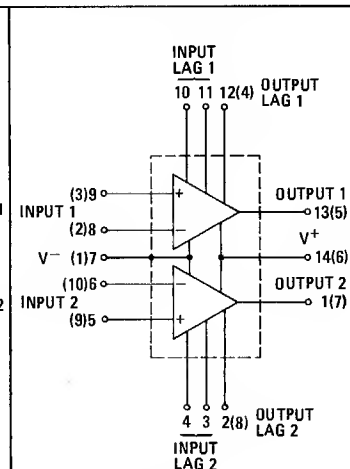
Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$	+10	Vdc
	$V^-$	-10	Vdc
Differential Input Signal	$V_{in}$	$\pm 5.0$	Volts
Common Mode Input Swing	$CMV_{in}$	$\pm V^+$	Volts
Output Short Circuit Duration	$t_S$	Continuous	
Power Dissipation (Package Limitation)	$P_D$	680	mW
		Derate above $25^{\circ}C$	$mW/^{\circ}C$
		4.6	
		500	mW
Flat Package		3.3	$mW/^{\circ}C$
		Derate above $25^{\circ}C$	
Operating Temperature Range	$T_A$	-55 to +125	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^{\circ}C$

### CIRCUIT SCHEMATIC



Number at end of terminal is pin number for flat package.  
Number in parenthesis is pin number for metal can package.  
Input Lag available only in flat package.

### EQUIVALENT CIRCUIT



# MC1535 (continued)

**ELECTRICAL CHARACTERISTICS** (Each Amplifier) ( $V^+ = +6.0\text{Vdc}$ ,  $V^- = -6.0\text{Vdc}$ ,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic Definitions (linear operations)	Characteristic	Symbol	Min	Typ	Max	Unit
	Open Loop Voltage Gain ( $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$A_{VOL}$	4,000 72	7,000 77	10,000 80	V/V dB
	Output Impedance ( $f = 20\text{ Hz}$ )	$Z_{out}$	-	1.7	-	k $\Omega$
	Input Impedance ( $f = 20\text{ Hz}$ )	$Z_{in}$	10	45	-	k $\Omega$
	Output Voltage Swing ( $R_L = 10\text{ k}\Omega$ )	$V_{out}$	$\pm 3.3$	$\pm 3.6$	-	V <sub>peak</sub>
	Input Common Mode Voltage Swing	$CMV_{in}$	+3.0 -2.0	+3.9 -2.7	-	V <sub>peak</sub>
	Common Mode Rejection Ratio	$CM_{rej}$	70	90	-	dB
	Input Bias Current ( $I_b = \frac{I_1 + I_2}{2}$ , $T_A = +25^\circ\text{C}$ ) ( $T_A = -55^\circ\text{C}$ )	$I_b$	-	1.2 3.6	3.0 6.0	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ ) ( $I_{io} = I_1 - I_2$ , $T_A = -55^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2$ , $T_A = +125^\circ\text{C}$ )	$I_{io}$	-	0.05 - -	0.3 0.9 0.3	$\mu\text{A}$
	Input Offset Voltage ( $T_A = 25^\circ\text{C}$ ) ( $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$V_{io}$	-	1.0 -	3.0 5.0	mV
	Step Response (Gain = 100, 30% overshoot, $R_1 = 4.7\text{ k}\Omega$ , $R_2 = 470\text{ k}\Omega$ , $R_3 = 150\text{ }\Omega$ , $C_1 = 1,000\text{ pF}$ ) (Gain = 10, 10% overshoot, $R_1 = 47\text{ k}\Omega$ , $R_2 = 470\text{ k}\Omega$ , $R_3 = 47\text{ }\Omega$ , $C_1 = 0.01\text{ }\mu\text{F}$ ) (Gain = 1, 5% overshoot, $R_1 = 47\text{ k}\Omega$ , $R_2 = 47\text{ k}\Omega$ , $R_3 = 4.7\text{ }\Omega$ , $C_1 = 0.1\text{ }\mu\text{F}$ )	$t_f$ $t_{pd}$ $dV_{out}/dt$ ① $t_f$ $t_{pd}$ $dV_{out}/dt$ ① $t_f$ $t_{pd}$ $dV_{out}/dt$ ①	- - - - - - - - -	0.8 0.1 7.0 0.4 0.3 4.0 0.5 0.25 0.67	- - - - - - - - -	$\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$ $\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$ $\mu\text{s}$ $\mu\text{s}$ V/ $\mu\text{s}$
	Average Temperature Coefficient of Input Offset Voltage ( $R_S = 50\text{ }\Omega$ , $T_A = 55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$TC_{V_{io}}$	-	3.0	-	$\mu\text{V}/^\circ\text{C}$
	Average Temperature Coefficient of Input Offset Current ( $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$TC_{I_{io}}$	-	2.0	-	nA/ $^\circ\text{C}$
	DC Power Dissipation (Power Supply = $\pm 6.0\text{ V}$ , $V_{out} = 0$ )	$P_D$	-	100	150	mW
	Positive Supply Sensitivity ( $V^-$ constant)	$S^+$	-	50	-	$\mu\text{V}/\text{V}$
	Negative Supply Sensitivity ( $V^+$ constant)	$S^-$	-	100	-	$\mu\text{V}/\text{V}$

## MATCHING CHARACTERISTICS

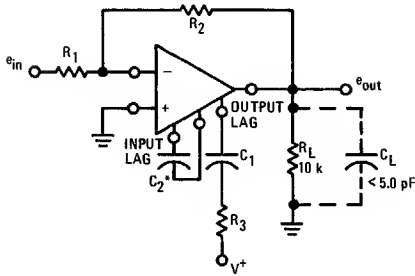
Same characteristic definitions as shown for each amplifier above.	Open Loop Voltage Gain	$A_{VOL1} - A_{VOL2}$	-	$\pm 1.0$	-	dB
	Input Bias Current	$I_{b1} - I_{b2}$	-	$\pm 0.15$	-	$\mu\text{A}$
	Input Offset Current	$I_{io1} - I_{io2}$	-	$\pm 0.02$	-	$\mu\text{A}$
	Average Temperature Coefficient	$TC_{I_{io1}} - TC_{I_{io2}}$	-	$\pm 0.1$	-	nA/ $^\circ\text{C}$
	Input Offset Voltage	$V_{io1} - V_{io2}$	-	$\pm 0.1$	-	mV
	Average Temperature Coefficient	$TC_{V_{io1}} - TC_{V_{io2}}$	-	$\pm 0.5$	-	mV/ $^\circ\text{C}$
	Channel Separation (See Fig. 10) ( $f = 10\text{ kHz}$ )	$\frac{e_{out1}}{e_{out2}}$	-	-60	-	dB

①  $dV_{out}/dt$  = Slew Rate

TYPICAL OUTPUT CHARACTERISTICS

$V^+ = +6.0 \text{ Vdc}$ ,  $V^- = -6.0 \text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$

FIGURE 1 – TEST CIRCUIT



\*MC1535F only.

FIGURE NO.	CURVE NO.	VOLTAGE GAIN	TEST CONDITIONS					OUTPUT NOISE (mV rms)
			$R_1(\Omega)$	$R_2(\Omega)$	$C_1(\mu\text{F})$	$R_3(\Omega)$	$C_2(\mu\text{F})$	
2	1	100	4.7 k	470 k	1,000	150	0	1.7
	1A	or 100	4.7 k	470 k	0	$\infty$	510	2.1
	2	10	47 k	470 k	10,000	47	0	1.0
	2A	or 10	47 k	470 k	0	$\infty$	5,000	2.1
	3	1	47 k	47 k	100,000	4.7	0	0.12
3	1	100	4.7 k	470 k	1,000	150	0	1.7
	1A	or 100	4.7 k	470 k	0	$\infty$	510	2.1
	2	10	47 k	470 k	10,000	47	0	1.0
	2A	or 10	47 k	470 k	0	$\infty$	5,000	2.1
	3	1	47 k	47 k	100,000	4.7	0	0.12
4	1	AVOL	100	$\infty$	1,000	150	0	8.1
	1A	or AVOL	100	$\infty$	0	$\infty$	510	8.1
	2	AVOL	100	$\infty$	10,000	47	0	5.5
	2A	or AVOL	100	$\infty$	0	$\infty$	5,000	5.5
	3	AVOL	100	$\infty$	100,000	4.7	0	4.4
	1	AVOL	100	$\infty$	0	$\infty$	50,000	4.4

FIGURE 2 – LARGE SIGNAL SWING versus FREQUENCY

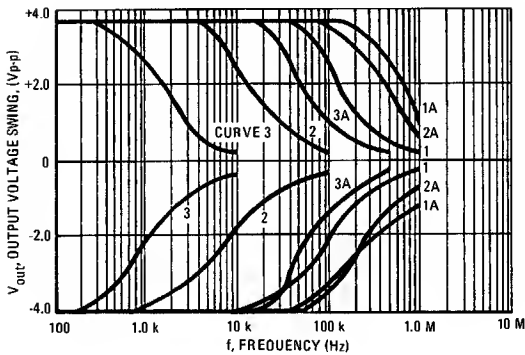


FIGURE 3 – VOLTAGE GAIN versus FREQUENCY

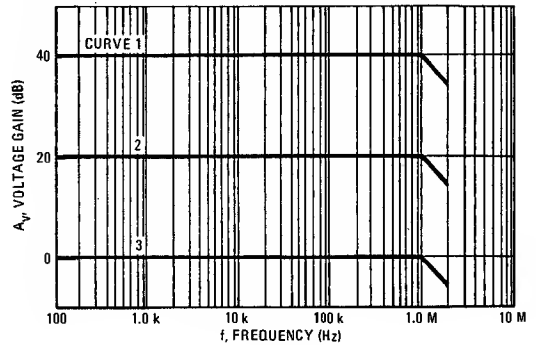


FIGURE 4 – OPEN LOOP VOLTAGE GAIN versus FREQUENCY

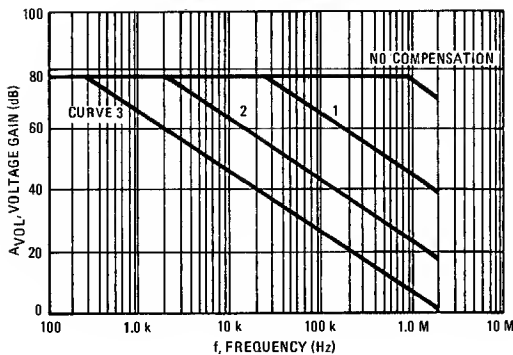
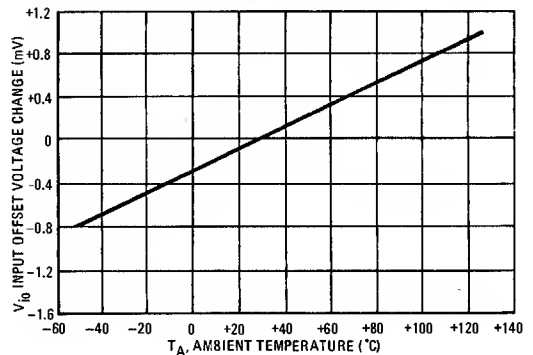
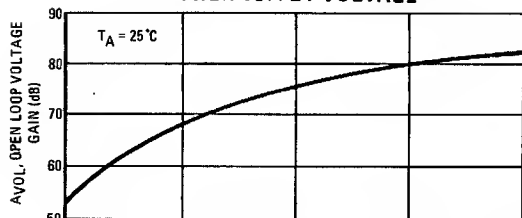


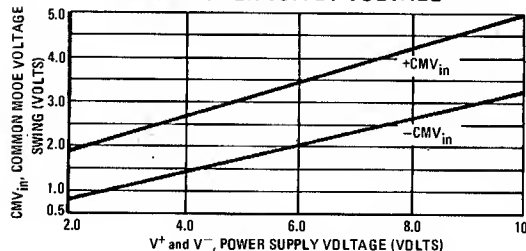
FIGURE 5 – INPUT OFFSET VOLTAGE versus TEMPERATURE



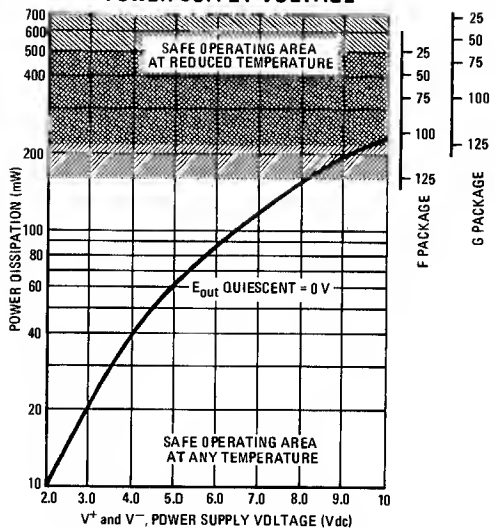
**FIGURE 6 – VOLTAGE GAIN versus POWER SUPPLY VOLTAGE**



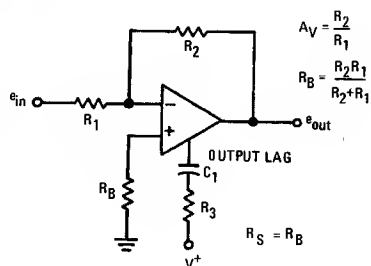
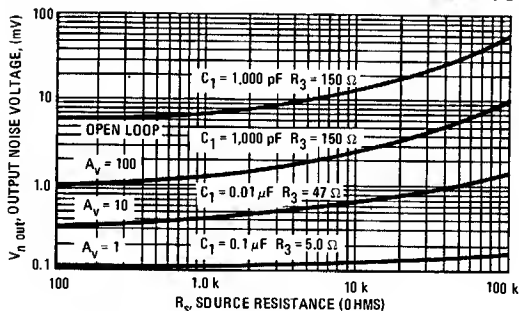
**FIGURE 7 – COMMON MODE SWING versus POWER SUPPLY VOLTAGE**



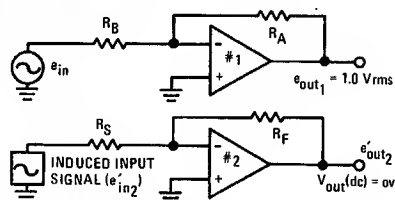
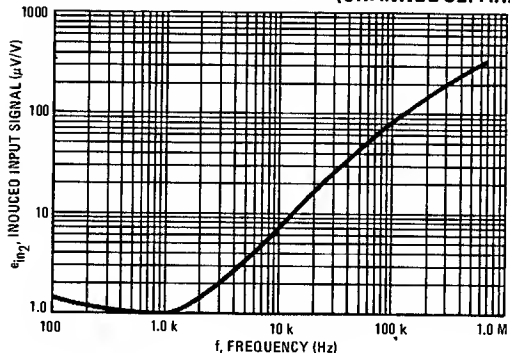
**FIGURE 8 – POWER DISSIPATION versus POWER SUPPLY VOLTAGE**



**FIGURE 9 – OUTPUT NOISE VOLTAGE versus SOURCE RESISTANCE**



**FIGURE 10 – INDUCED INPUT SIGNAL (CHANNEL SEPARATION) versus FREQUENCY**



Induced input signal ( $\mu\text{V}$  of induced input signal in amplifier #2 per volt of output signal at amplifier #1)

$e'_{out2} = e'_{in2} \left(1 + \frac{R_F}{R_S}\right)$ , where  $e'_{out2}$  is the component of  $e_{out2}$  due only to lack of perfect separation between the two amplifiers.



## OPERATIONAL AMPLIFIER

## OPERATIONAL AMPLIFIERS

### MC1539G

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.

#### Typical Amplifier Features:

- Low Input Offset Voltage — 3.0 mV max
- Low Input Offset Current — 60 nA max
- Large Power-Bandwidth — 20 V<sub>p-p</sub> Output Swing at 20 kHz min
- Output Short-Circuit Protection
- Input Over-Voltage Protection
- Class AB Output for Excellent Linearity
- Slew Rate — 34 V/ $\mu$ s typ



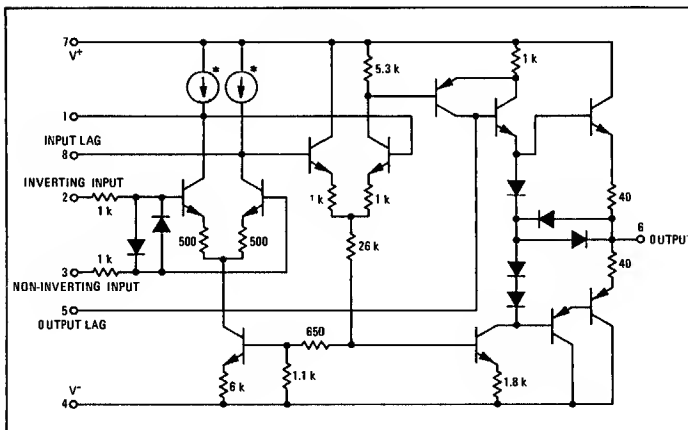
Lead 4 connected to case

CASE 96  
(TO-99)  
"G" SUFFIX

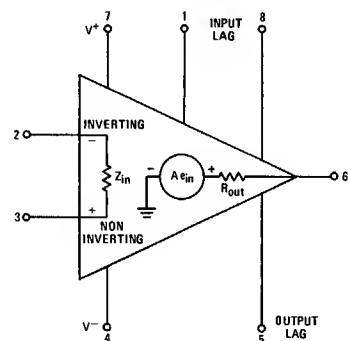
#### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+18 -18	Vdc Vdc
Differential Input Signal	$V_{in}$	$\pm V^+$	Volts
Common Mode Input Swing	$CMV_{in}$	$\pm V^+$	Volts
Load Current	$I_L$	15	mA
Output Short Circuit Duration	$t_S$	Continuous	
Power Dissipation (Package Limitation) Derate above $T_A = 25^\circ\text{C}$	$P_D$	680 4.6	mW mW/ $^\circ\text{C}$
Operating Temperature Range	$T_A$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$

#### CIRCUIT SCHEMATIC

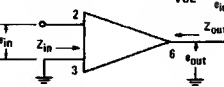

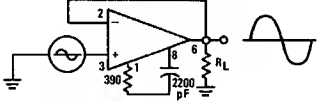
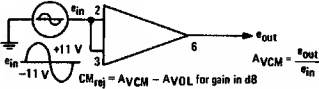
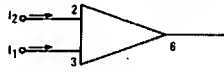
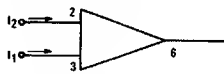
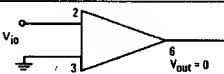
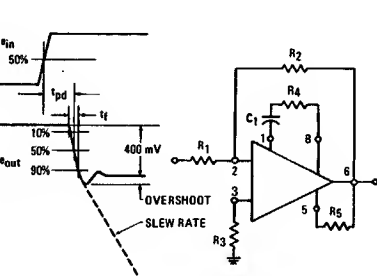
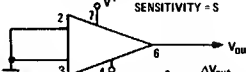


#### EQUIVALENT CIRCUIT



\*PATENT PENDING

**MC1539G (continued)****ELECTRICAL CHARACTERISTICS** ( $V^+ = +15$  Vdc,  $V^- = -15$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic Definitions (linear operation)	Characteristic	Symbol	Min	Typ	Max	Unit
 $A_{VOL} = \frac{e_{out}}{e_{in}}$	Open Loop Voltage Gain ( $V_{out} = \pm 10 \text{ V}$ , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$A_{VOL}$	50,000	120,000	-	-
	Output Impedance ( $f = 20 \text{ Hz}$ )	$Z_{out}$	-	4.0	-	k $\Omega$
	Input Impedance ( $f = 20 \text{ Hz}$ )	$Z_{in}$	150	300	-	k $\Omega$
	Output Voltage Swing ( $R_L = 10 \text{ k}\Omega$ ) ( $R_L = 1.0 \text{ k}\Omega$ )	$V_{out}$	$\pm 12$ $\pm 10$	$\pm 14$ $\pm 13$	-	$V_{peak}$
	Power Bandwidth ( $A_v = 1$ , $R_L = 1.0 \text{ k}\Omega$ , $THD \leq 5\%$ , $V_O = 20 \text{ V}_{p-p}$ )	$P_{BW}$	20	50	-	kHz
	Input Common Mode Voltage Swing	$CMV_{in}$	$\pm 11$	$\pm 12$	-	$V_{peak}$
	Common Mode Rejection Ratio	$CM_{rej}$	80	100	-	dB
	Input Bias Current $I_b = \frac{I_1 + I_2}{2}$ ( $T_A = +25^\circ\text{C}$ ) ( $T_A = -55^\circ\text{C}$ )	$I_b$	-	200 230	500 700	nA
	Input Offset Current ( $I_{io} = I_1 - I_2$ ) ( $I_{io} = I_1 - I_2$ , $T_A = -55^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2$ , $T_A = +125^\circ\text{C}$ )	$I_{io}$	-	20 -	60 75 75	nA
	Input Offset Voltage ( $T_A = 25^\circ\text{C}$ ) ( $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$V_{io}$	-	1.0 -	3.0 4.0	mV
	Step Response (Gain = 100, no overshoot, $R_1 = 1.0 \text{ k}\Omega$ , $R_2 = 100 \text{ k}\Omega$ , $R_3 = 1.0 \text{ k}\Omega$ , $R_4 = 10 \text{ k}\Omega$ , $R_5 = 10 \text{ k}\Omega$ , $C_1 = 2200 \text{ pF}$ ) (Gain = 100, no overshoot, $R_1 = 1.0 \text{ k}\Omega$ , $R_2 = 100 \text{ k}\Omega$ , $R_3 = 1.0 \text{ k}\Omega$ , $R_4 = 10 \text{ k}\Omega$ , $R_5 = \infty$ , $C_1 = 2200 \text{ pF}$ ) (Gain = 10, 15% overshoot, $R_1 = 1.0 \text{ k}\Omega$ , $R_2 = 10 \text{ k}\Omega$ , $R_3 = 1.0 \text{ k}\Omega$ , $R_4 = 1.0 \text{ k}\Omega$ , $R_5 = 10 \text{ k}\Omega$ , $C_1 = 2200 \text{ pF}$ ) (Gain = 10, 15% overshoot, $R_1 = 1.0 \text{ k}\Omega$ , $R_2 = 10 \text{ k}\Omega$ , $R_3 = 1.0 \text{ k}\Omega$ , $R_4 = 1.0 \text{ k}\Omega$ , $R_5 = \infty$ , $C_1 = 2200 \text{ pF}$ ) (Gain = 1, 15% overshoot, $R_1 = 10 \text{ k}\Omega$ , $R_2 = 10 \text{ k}\Omega$ , $R_3 = 5.0 \text{ k}\Omega$ , $R_4 = 390 \Omega$ , $R_5 = 10 \text{ k}\Omega$ , $C_1 = 2200 \text{ pF}$ ) (Gain = 1, 15% overshoot, $R_1 = 10 \text{ k}\Omega$ , $R_2 = 10 \text{ k}\Omega$ , $R_3 = 5.0 \text{ k}\Omega$ , $R_4 = 390 \Omega$ , $R_5 = \infty$ , $C_1 = 2200 \text{ pF}$ )	$t_f$ $\frac{dV_{out}}{dt}$ $t_f$ $\frac{dV_{out}}{dt}$ $t_f$ $\frac{dV_{out}}{dt}$ $t_f$ $\frac{dV_{out}}{dt}$ $t_f$ $\frac{dV_{out}}{dt}$ $t_f$ $\frac{dV_{out}}{dt}$ $t_f$ $\frac{dV_{out}}{dt}$ $t_f$ $\frac{dV_{out}}{dt}$	-	700 100 34 700 100 1.7 600 80 6.25 600 80 1.7 400 80 4.2 400 80 1.4	-	ns ns V/ $\mu$ s ns ns V/ $\mu$ s ns ns V/ $\mu$ s ns ns V/ $\mu$ s ns ns V/ $\mu$ s ns ns V/ $\mu$ s
	Equivalent Input Noise Voltage (Open Loop) ( $R_S = 10 \text{ k}\Omega$ ) Noise Bandwidth = $1.0 \text{ Hz}$ , $f = 1.0 \text{ kHz}$ )	$e_n$	-	30	-	nV/(Hz) $^{1/2}$
	Average Temperature Coefficient of Input Offset Voltage ( $R_S = 50 \Omega$ , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ ) ( $R_S = 10 \text{ k}\Omega$ , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$TC_{V_{io}}$	-	3.0 5.0	-	$\mu\text{V}/^\circ\text{C}$
	DC Power Dissipation (Power Supply = $\pm 15 \text{ V}$ , $V_{out} = 0$ )	$P_D$	-	90	150	mW
	Positive Supply Sensitivity ( $V^+$ constant)	$S^+$	-	50	150	$\mu\text{V}/\text{V}$
	Negative Supply Sensitivity ( $V^+$ constant)	$S^-$	-	50	150	$\mu\text{V}/\text{V}$

\*To improve performance, development is in process to include resistor  $R_5 \approx 10 \text{ k}\Omega$  on the device chip. Available after September 1968.

# TYPICAL OUTPUT CHARACTERISTICS

( $V^+ = +15$  Vdc,  $V^- = -15$  Vdc,  $T_A = 25^\circ\text{C}$ )

FIGURE NO.	CURVE NO.	VOLTAGE GAIN	TEST CONDITIONS (FIGURE 1)					
			$R_1(\Omega)$	$R_2(\Omega)$	$R_3(\Omega)$	$R_4(\Omega)$	$R_5^*(\Omega)$	$C_1(\text{pF})$
2	1	1.0	10 k	10 k	5.0 k	390	10 k	2200
	2	1.0	10 k	10 k	5.0 k	390	$\infty$	2200
3	1	AVOL	0	$\infty$	0	$\infty$	$\infty$	0
	2	1000	1000	1.0 M	1000	0	$\infty$	10
	3	100	1000	100 k	1000	10 k	$\infty$	2200
	4	10	1000	10 k	1000	1.0 k	$\infty$	2200
	5	1.0	10 k	10 k	5.0 k	390	$\infty$	2200
4	1	AVOL	0	$\infty$	0	$\infty$	$\infty$	0
	2	AVOL	0	$\infty$	0	10 k	$\infty$	2200
	3	AVOL	0	$\infty$	0	390	$\infty$	2200

\*To improve performance, development is in process to include resistor  $R_5 \approx 10$  k $\Omega$  on the device chip.  
Available after September 1968.

FIGURE 1 – TEST CIRCUIT

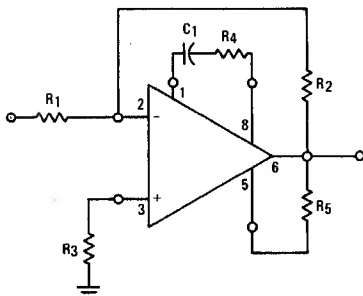


FIGURE 2 – POWER BANDWIDTH  
(LARGE SIGNAL SWING versus FREQUENCY)

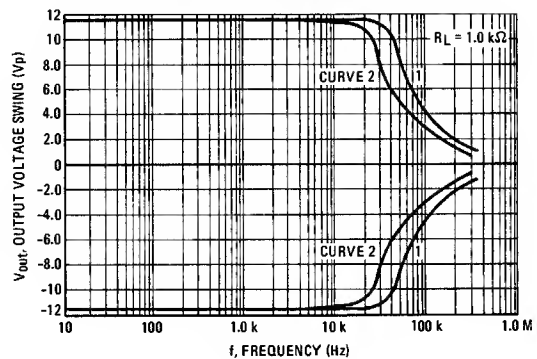


FIGURE 3 – VOLTAGE GAIN versus FREQUENCY

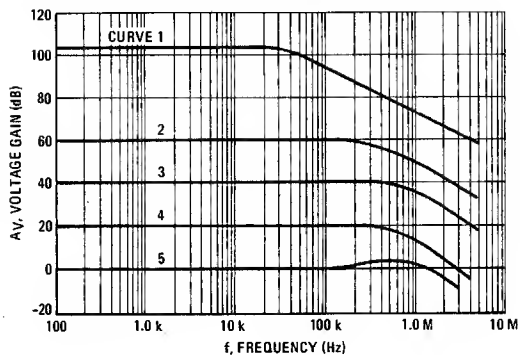
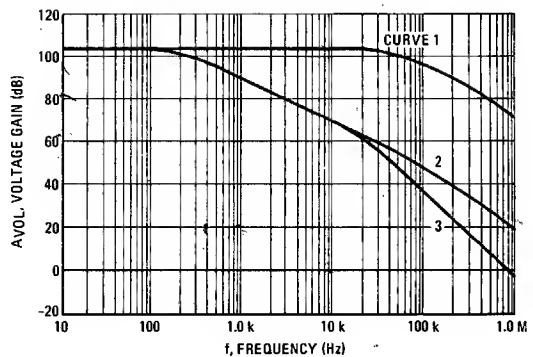
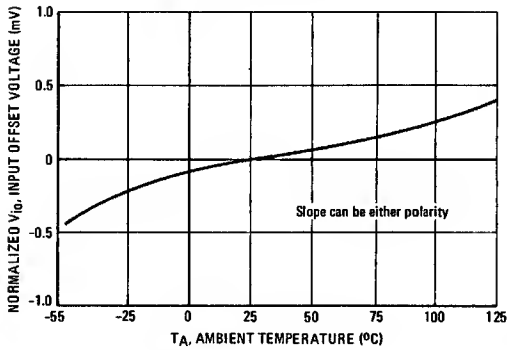


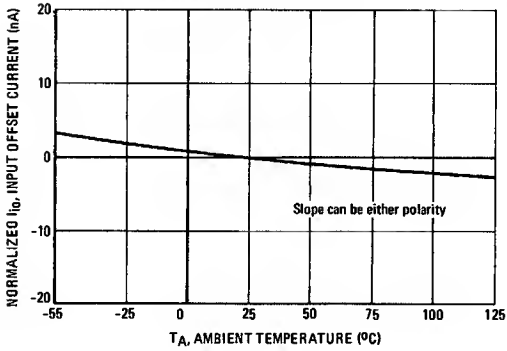
FIGURE 4 – OPEN LOOP VOLTAGE GAIN  
versus FREQUENCY



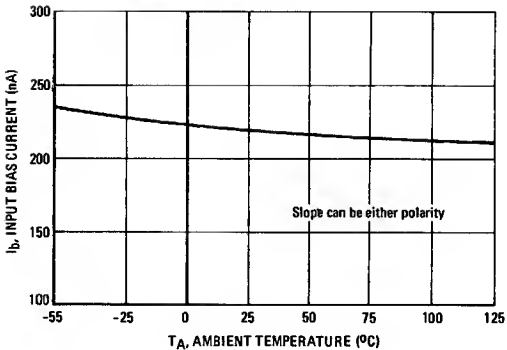
**FIGURE 5 – INPUT OFFSET VOLTAGE  
versus TEMPERATURE**



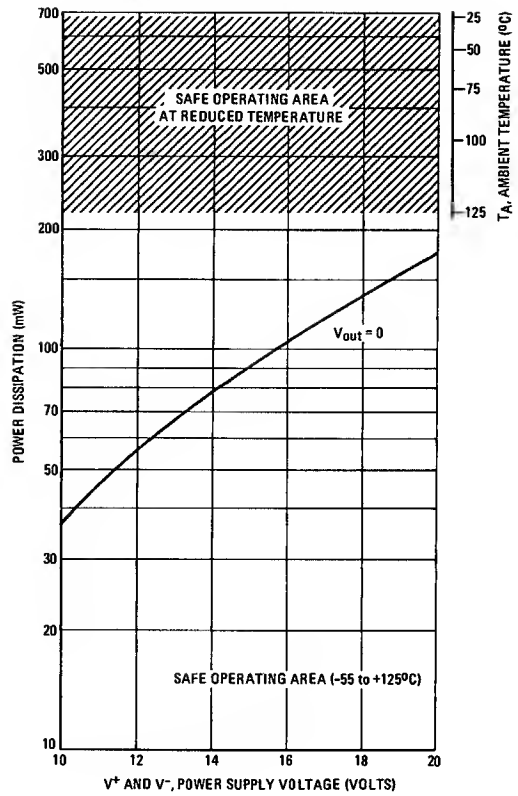
**FIGURE 6 – INPUT OFFSET CURRENT  
versus TEMPERATURE**



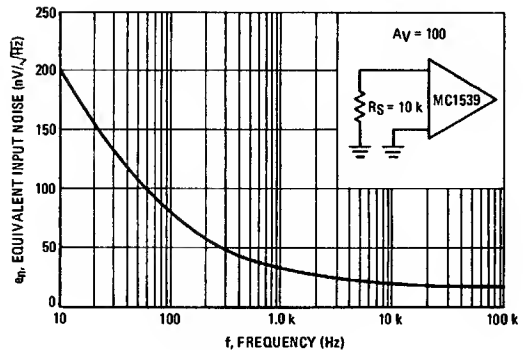
**FIGURE 8 – INPUT BIAS CURRENT  
versus TEMPERATURE**



**FIGURE 7 – POWER DISSIPATION  
versus POWER SUPPLY VOLTAGE**



**FIGURE 9 – SPECTRAL NOISE DENSITY**



# OPERATIONAL AMPLIFIER

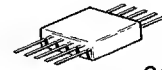
# OPERATIONAL AMPLIFIERS

## MC1709

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.



CASE 96  
(TO-99)  
"G" SUFFIX



CASE 72  
(TO-91)  
"F" SUFFIX

### Typical Amplifier Features:

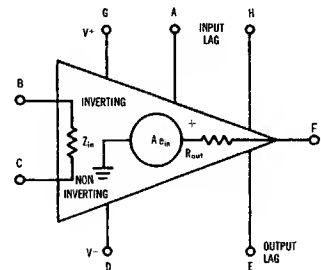
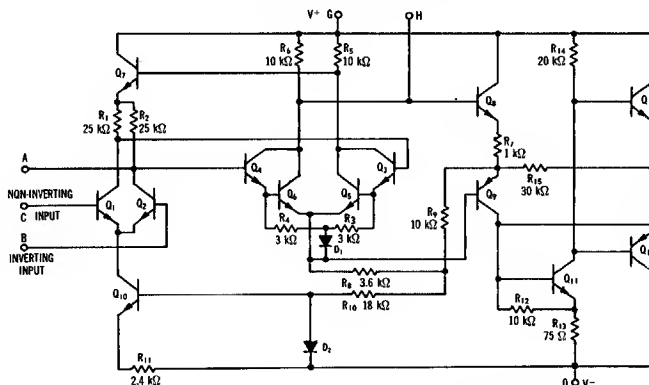
- High-Performance Open Loop Gain Characteristics  
 $A_{VOL} = 45,000$  typical
- Low Temperature Drift —  $\pm 3.0 \mu V/^\circ C$
- Large Output Voltage Swing —  
 $\pm 14 V$  typical @  $\pm 15 V$  Supply
- Low Output Impedance —  
 $Z_{out} = 150$  ohms typical

### MAXIMUM RATINGS ( $T_A = 25^\circ C$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+18 -18	Vdc Vdc
Differential Input Signal	$V_{in}$	$\pm 5.0$	Volts
Common Mode Input Swing	$CMV_{in}$	$\pm V^+$	Volts
Load Current	$I_L$	10	mA
Output Short Circuit Duration	$t_S$	5.0	s
Power Dissipation (Package Limitation)	$P_D$	680 4.6 500 3.3	mW mW/ $^\circ C$ mW/ $^\circ C$ mW/ $^\circ C$
Operating Temperature Range	$T_A$	-55 to +125	$^\circ C$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ C$

### CIRCUIT SCHEMATIC

### EQUIVALENT CIRCUIT



### PIN CONNECTIONS

Schematic	A	B	C	D	E	F	G	H
"G" Package	1	2	3	4	5	6	7	8
"F" Package	2	3	4	5	6	7	8	9

ELECTRICAL CHARACTERISTICS ( $V^+ = +15$  Vdc,  $V^- = -15$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic Definitions <sup>①</sup>	Characteristic	Symbol	Min	Typ	Max	Unit
	Open Loop Voltage Gain ( $V_{out} = \pm 10$ V, $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$A_{VOL}$	25,000	45,000	70,000	-
	Output Impedance ( $f = 20$ Hz)	$Z_{out}$	-	150	-	$\Omega$
	Input Impedance ( $f = 20$ Hz)	$Z_{in}$	150	400	-	$k\Omega$
	Output Voltage Swing ( $R_L = 10$ $k\Omega$ ) ( $R_L = 2$ $k\Omega$ )	$V_{out}$	$\pm 12$ $\pm 10$	$\pm 14$ $\pm 13$	-	$V_{peak}$
	Input Common Mode Voltage Swing	$CMV_{in}$	$\pm 8$	$\pm 10$	-	$V_{peak}$
	Common Mode Rejection Ratio	$CM_{rej}$	70	90	-	dB
	Input Bias Current ( $I_b = \frac{I_1 + I_2}{2}$ ) ( $T_A = +25^\circ\text{C}$ ) ( $I_b = \frac{I_1 + I_2}{2}$ ) ( $T_A = -55^\circ\text{C}$ )	$I_b$	-	0.2 0.5	0.5 1.5	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ ) ( $T_A = +25^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2$ ) ( $T_A = -55^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2$ ) ( $T_A = +125^\circ\text{C}$ )	$I_{io}$	-	0.05 - -	0.2 0.5 0.2	$\mu\text{A}$
	Input Offset Voltage ( $T_A = 25^\circ\text{C}$ ) ( $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$V_{io}$	-	1.0 -	5.0 6.0	mV
	Step Response (Gain = 100, 5% overshoot, $R_1 = 1$ $k\Omega$ , $R_2 = 100$ $k\Omega$ , $R_3 = 1.5$ $k\Omega$ , $C_1 = 100$ pF, $C_2 = 3$ pF) (Gain = 10, 10% overshoot, $R_1 = 1$ $k\Omega$ , $R_2 = 10$ $k\Omega$ , $R_3 = 1.5$ $k\Omega$ , $C_1 = 500$ pF, $C_2 = 20$ pF) (Gain = 1, 5% overshoot, $R_1 = 10$ $k\Omega$ , $R_2 = 10$ $k\Omega$ , $R_3 = 1.5$ $k\Omega$ , $C_1 = 5000$ pF, $C_2 = 200$ pF)	$t_f$ $t_{pd}$ $dV_{out}/dt$ ②	-	0.8 0.38 12.0	-	$\mu\text{s}$ $\mu\text{s}$ $V/\mu\text{s}$
	Average Temperature Coefficient of Input Offset Voltage ( $R_S = 50$ $\Omega$ , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ ) ( $R_S \leq 10$ $k\Omega$ , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$TC_{V_{io}}$	-	3.0 6.0	-	$\mu\text{V}/^\circ\text{C}$
	DC Power Dissipation (Power Supply = $\pm 15$ V, $V_{out} = 0$ )	$P_D$	-	80	165	mW
	Positive Supply Sensitivity ( $V^-$ constant)	$S^+$	-	25	150	$\mu\text{V}/\text{V}$
	Negative Supply Sensitivity ( $V^+$ constant)	$S^-$	-	25	150	$\mu\text{V}/\text{V}$

① All definitions imply linear operation

②  $dV_{out}/dt$  = Slew Rate

TYPICAL OUTPUT CHARACTERISTICS

FIGURE 1 — TEST CIRCUIT  
 $V^+ = +15\text{ Vdc}$ ,  $V^- = -15\text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$

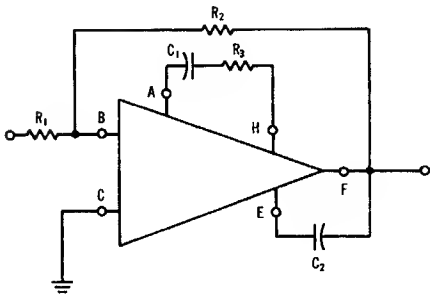


Fig. No.	Curve No.	Test Conditions				
		$R_1(\Omega)$	$R_2(\Omega)$	$R_3(\Omega)$	$C_1(\text{pF})$	$C_2(\text{pF})$
2	1	10 k	10 k	1.5 k	5 k	200
	2	10 k	100 k	1.5 k	500	20
	3	10 k	1M	1.5 k	100	3
	4	1 k	1M	0	10	3
3	1	1 k	1M	0	10	3
	2	10 k	1M	1.5 k	100	3
	3	10 k	100 k	1.5 k	500	20
	4	10 k	10 k	1.5 k	5 k	200
4	1	0	$\infty$	1.5 k	5 k	200
	2	0	$\infty$	1.5 k	500	20
	3	0	$\infty$	1.5 k	100	3
	4	0	$\infty$	0	10	3

FIGURE 2 — LARGE SIGNAL SWING versus FREQUENCY

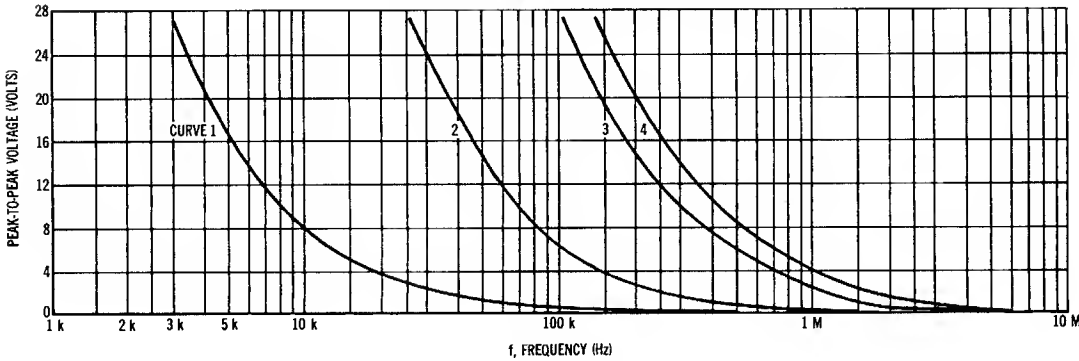


FIGURE 3 — VOLTAGE GAIN versus FREQUENCY

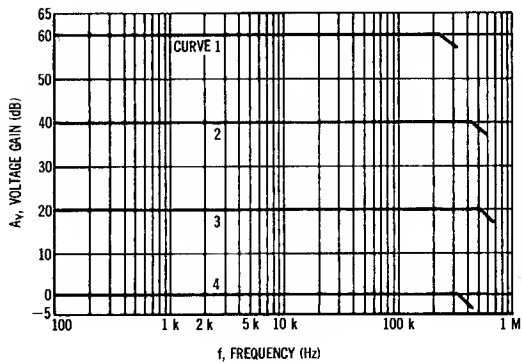


FIGURE 4 — OPEN LOOP VOLTAGE GAIN versus FREQUENCY

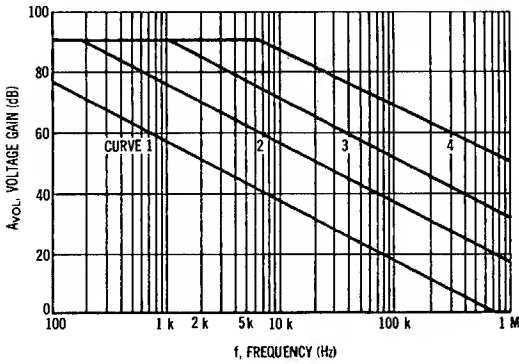


FIGURE 5 — POWER DISSIPATION  
versus POWER SUPPLY VOLTAGE

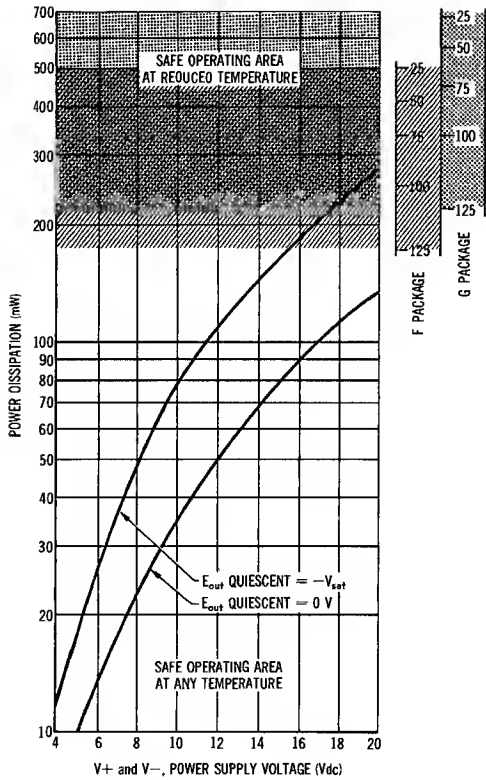


FIGURE 6 — VOLTAGE GAIN versus POWER SUPPLY VOLTAGE

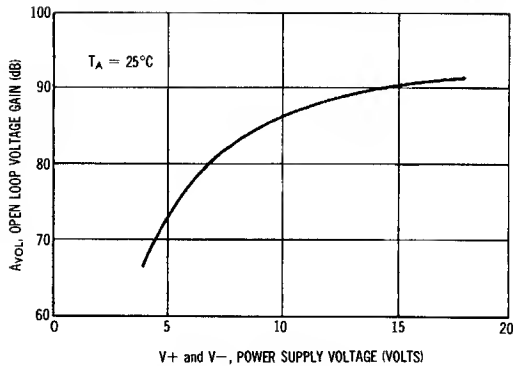


FIGURE 7 — COMMON SWING versus POWER SUPPLY VOLTAGE

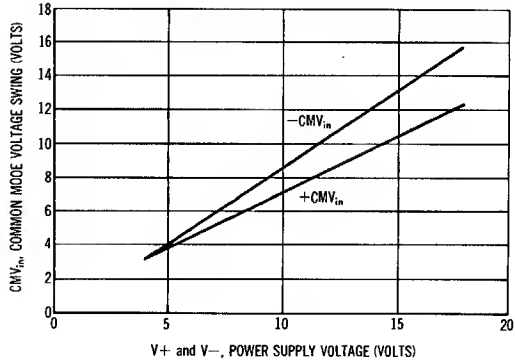


FIGURE 8 — INPUT OFFSET VOLTAGE versus TEMPERATURE

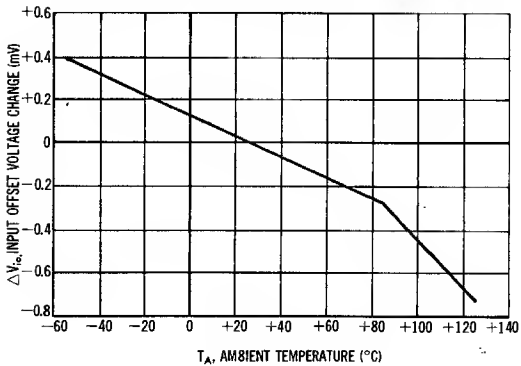
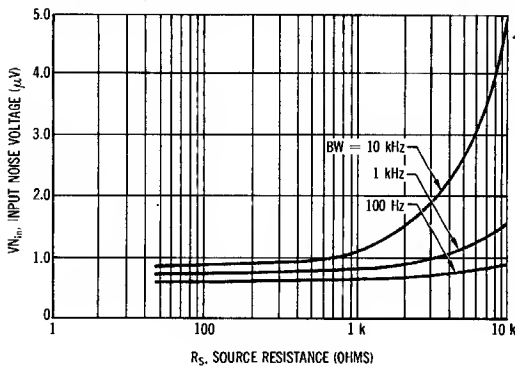


FIGURE 9 — INPUT NOISE VOLTAGE versus SOURCE RESISTANCE





# OPERATIONAL AMPLIFIER

# OPERATIONAL AMPLIFIERS

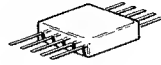
## MC1709C

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.



Lead 4 connected to case

CASE 96  
(TO-99)  
"G" SUFFIX



CASE 72  
(TO-91)  
"F" SUFFIX



CASE 93  
(TO-116)  
"P" SUFFIX

### Typical Amplifier Features:

- High-Performance Open Loop Gain Characteristics  
AVOL = 45,000 typical
- Low Temperature Drift —  $\pm 3.0 \mu\text{V}/^\circ\text{C}$
- Large Output Voltage Swing —  
 $\pm 14 \text{ V}$  typical @  $\pm 15 \text{ V}$  Supply
- Low Output Impedance —  $Z_{\text{out}} = 150$  ohms typical

PIN CONNECTIONS								
Schematic	A	B	C	D	E	F	G	H
"G" Package	1	2	3	4	5	6	7	8
"F" Package	2	3	4	5	6	7	8	9
"P" Package	3	4	5	6*	9	10	11	12

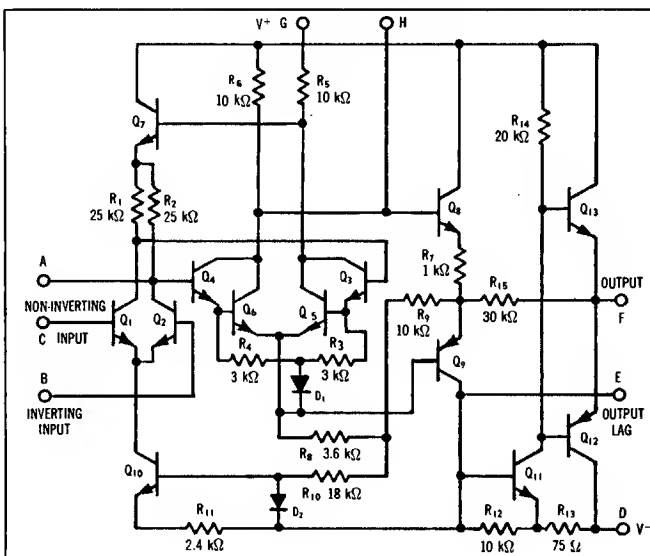
\*Pin 7 is electrically connected to substrate and  $V^-$

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

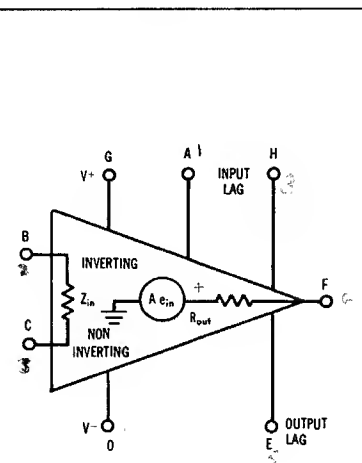
Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+18 -18	Vdc Vdc
Differential Input Signal	$V_{\text{in}}$	$\pm 5.0$	Volts
Common Mode Input Swing	$\text{CMV}_{\text{in}}$	$\pm V^+$	Volts
Load Current	$I_L$	10	mA
Output Short Circuit Duration	$t_S$	5.0	s
Power Dissipation (Package Limitation)	$P_D$		
Metal Can Derate above $25^\circ\text{C}$		680	mW
Flat Package Derate above $25^\circ\text{C}$		4.6	mW/ $^\circ\text{C}$
Plastic Package Derate above $25^\circ\text{C}$		500	mW
		3.3	mW/ $^\circ\text{C}$
		400	mW
		3.3	mW/ $^\circ\text{C}$
Operating Temperature Range*	$T_A$	0 to +75	$^\circ\text{C}$
Storage Temperature Range	$T_{\text{stg}}$		$^\circ\text{C}$
Metal Can and Flat Package		-65 to +150	
Plastic Package		-65 to +125	

\* For full temperature range ( $-55^\circ\text{C}$  to  $+125^\circ\text{C}$ ) and characteristic curves, see MC1709 data sheet.

### CIRCUIT SCHEMATIC

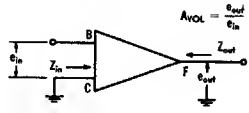
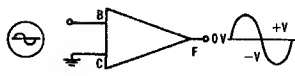
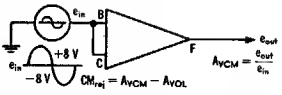
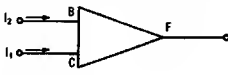
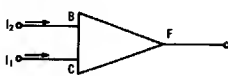
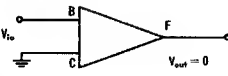
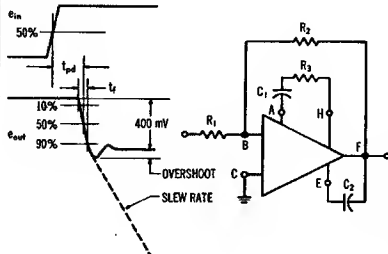
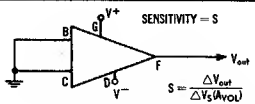


### EQUIVALENT CIRCUIT



# MC1709C (continued)

## ELECTRICAL CHARACTERISTICS ( $V^+ = +15$ Vdc, $V^- = -15$ Vdc, $T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic Definitions (linear operation)	Characteristic	Symbol	Min	Typ	Max	Unit
 $A_{VOL} = \frac{e_{out}}{e_{in}}$	Open Loop Voltage Gain ( $R_L = 2\text{ k}\Omega$ , $V_{out} = \pm 10\text{ V}$ , $T_A = 0^\circ\text{C}$ to $+75^\circ\text{C}$ )	$A_{VOL}$	15,000	45,000	-	-
	Output Impedance ( $f = 20\text{ Hz}$ )	$Z_{out}$	-	150	-	$\Omega$
	Input Impedance ( $f = 20\text{ Hz}$ )	$Z_{in}$	50	250	-	$\text{k}\Omega$
	Output Voltage Swing ( $R_L = 10\text{ k}\Omega$ ) ( $R_L = 2\text{ k}\Omega$ )	$V_{out}$	$\pm 12$ $\pm 10$	$\pm 14$ $\pm 13$	-	$V_{peak}$
 $CM_{rej} = A_{VOL} - A_{VOL}$	Input Common Mode Voltage Swing	$CMV_{in}$	$\pm 8.0$	$\pm 10$	-	$V_{peak}$
	Common Mode Rejection Ratio	$CM_{rej}$	65	90	-	dB
	Input Bias Current ( $I_b = \frac{I_1 + I_2}{2}$ ), ( $T_A = +25^\circ\text{C}$ ) ( $T_A = 0^\circ\text{C}$ )	$I_b$	-	0.3	1.5	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ ), ( $T_A = 0^\circ\text{C}$ ) ( $I_{io} = I_1 - I_2$ ), ( $T_A = +75^\circ\text{C}$ )	$I_{io}$	-	0.1	0.5	$\mu\text{A}$
	Input Offset Voltage ( $T_A = 25^\circ\text{C}$ ) ( $T_A = 0^\circ\text{C}, +75^\circ\text{C}$ )	$V_{io}$	-	2.0	7.5	mV
	Step Response (Gain = 100, 5% overshoot, $R_1 = 1\text{ k}\Omega$ , $R_2 = 100\text{ k}\Omega$ , $R_3 = 1.5\text{ k}\Omega$ , $C_1 = 100\text{ pF}$ , $C_2 = 3\text{ pF}$ )	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	-	0.8	-	$\mu\text{s}$
	(Gain = 10, 10% overshoot, $R_1 = 1\text{ k}\Omega$ , $R_2 = 10\text{ k}\Omega$ , $R_3 = 1.5\text{ k}\Omega$ , $C_1 = 500\text{ pF}$ , $C_2 = 20\text{ pF}$ )	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	-	0.6	-	$\mu\text{s}$
	(Gain = 1, 5% overshoot, $R_1 = 10\text{ k}\Omega$ , $R_2 = 10\text{ k}\Omega$ , $R_3 = 1.5\text{ k}\Omega$ , $C_1 = 5000\text{ pF}$ , $C_2 = 200\text{ pF}$ )	$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	-	2.2	-	$\mu\text{s}$
		$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	-	0.38	-	$\mu\text{s}$
		$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	-	12	-	$V/\mu\text{s}$
		$t_f$ $t_{pd}$ $dV_{out}/dt$ ①	-	0.34	-	$\mu\text{s}$
	Average Temperature Coefficient of Input Offset Voltage ( $R_S = 50\text{ }\Omega$ , $T_A = 0^\circ\text{C}$ to $+75^\circ\text{C}$ ) ( $R_S \leq 10\text{ k}\Omega$ , $T_A = 0^\circ\text{C}$ to $+75^\circ\text{C}$ )	$TC_{V_{io}}$	-	3.0	-	$\mu\text{V}/^\circ\text{C}$
	DC Power Dissipation (Power Supply = $\pm 15\text{ V}$ , $V_{out} = 0$ )	$P_D$	-	80	200	mW
	Positive Supply Sensitivity ( $V^-$ constant)	$S^+$	-	25	200	$\mu\text{V}/\text{V}$
	Negative Supply Sensitivity ( $V^+$ constant)	$S^-$	-	25	200	$\mu\text{V}/\text{V}$

①  $dV_{out}/dt$  = Slew Rate

# WIDEBAND DC AMPLIFIER

# OPERATIONAL AMPLIFIERS

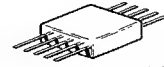
## MC1712

... designed for use as an operational amplifier utilizing operating characteristics as a function of the external feedback components.



CASE 96  
(TO-99)  
"G" SUFFIX

Lead 4 connected to case



CASE 72  
(TO-91)  
"F" SUFFIX

### Typical Amplifier Features:

- Open Loop Gain  $A_{VOL} = 3600$  typical
- Low Temperature Drift  $-\pm 2.5 \mu V/^{\circ}C$
- Output Swing  $-\pm 5.3 V$  typical @  $+12 V$  and  $-6.0 V$  Supplies
- Low Output Impedance  $-Z_{out} = 200$  ohms typical

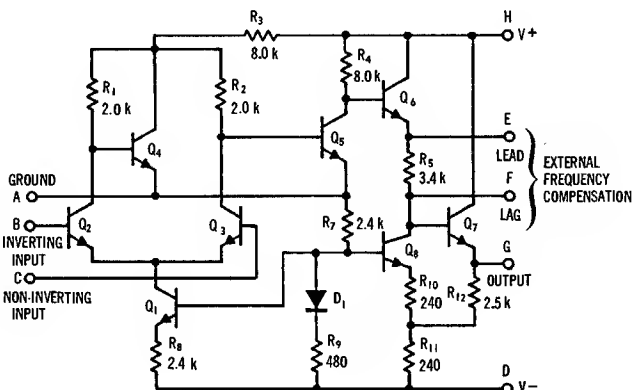
### MAXIMUM RATINGS ( $T_A = 25^{\circ}C$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage (Total between $V^+$ and $V^-$ terminals)	$ V^+  +  V^- $	21	Vdc
Differential Input Signal	$V_{in}$	$\pm 5.0$	Volts
Common Mode Input Swing	$CMV_{in}$	$+1.5$ $-6.0$	Volts
Peak Load Current	$I_L$	50	mA
Power Dissipation (Package Limitation)	$P_D$		
Metal Can Derate above $T_A = 25^{\circ}C$		680 4.6	mW mW/ $^{\circ}C$
Flat Package Derate above $T_A = 25^{\circ}C$		500 3.3	mW mW/ $^{\circ}C$
Operating Temperature Range	$T_A$	$-55$ to $+125$	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	$-65$ to $+150$	$^{\circ}C$

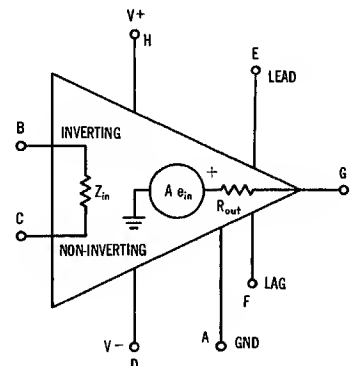
### PIN CONNECTIONS

Schematic	A	B	C	D	E	F	G	H
"G" Package	1	2	3	4	5	6	7	8
"F" Package	2	3	4	5	6	7	8	10

### CIRCUIT SCHEMATIC

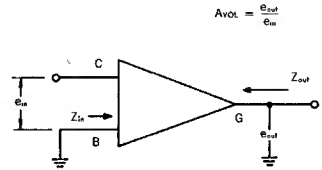
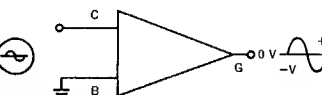
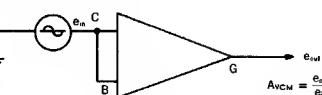
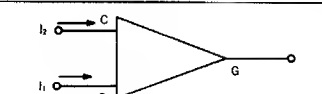
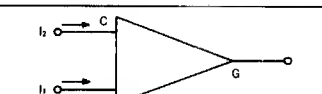
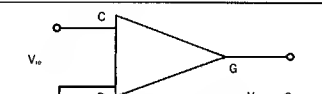
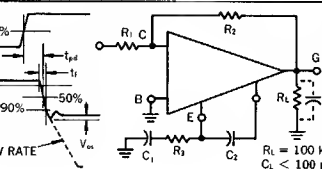
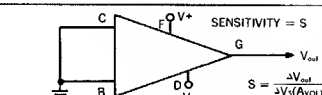


### EQUIVALENT CIRCUIT



# MC1712 (continued)

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic Definitions ①	Characteristic	Symbol	Min	Typ	Max	Unit
 $A_{VOL} = \frac{e_{out}}{e_{in}}$	Open Loop Voltage Gain $R_L = 100 \text{ k}\Omega$ (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, V <sub>out</sub> = ± 2.5 V) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, V <sub>out</sub> = ± 5.0 V) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, V <sub>out</sub> = ± 5.0 Vdc, T <sub>A</sub> = -55, +125°C) (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, V <sub>out</sub> = ± 2.5 V, T <sub>A</sub> = -55 to +125°C)	A <sub>VOL</sub>	600 2500 2000 500	900 3600 7000 1750	1500 6000 7000 1750	V/V
	Output Impedance (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, f = 20 Hz) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, f = 20 Hz)	Z <sub>out</sub>	- -	300 200	700 500	ohms
	Input Impedance (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, f = 20 Hz) (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, f = 20 Hz, T <sub>A</sub> = -55°C, +125°C) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, f = 20 Hz) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, f = 20 Hz, T <sub>A</sub> = -55°C, +125°C)	Z <sub>in</sub>	22 8.0 16 6.0	70 - 40 -	- - - -	k ohms
	Output Voltage Swing (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, R <sub>L</sub> = 100 kΩ) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, R <sub>L</sub> = 100 kΩ) (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, R <sub>L</sub> = 10 kΩ) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, R <sub>L</sub> = 10 kΩ)	V <sub>out</sub>	±2.5 ±5.0 ±1.5 ±3.5	±2.7 ±5.3 ±2.0 ±4.0	- - - -	V <sub>peak</sub>
 $CM_{in} = \frac{e_{out}}{e_{in}} - A_{VOL}$	Input Common Mode Voltage Swing (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc)	CM <sub>in</sub>	+0.5 -1.5 +0.5 -4.0	- - - -	- - - -	V <sub>peak</sub>
	Common Mode Rejection Ratio (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, f ≤ 1.0 kHz) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, f ≤ 1.0 kHz)	CM <sub>rej</sub>	80 80	100 100	- -	dB
	Input Bias Current T <sub>A</sub> = 25°C (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc) T <sub>A</sub> = -55°C (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc)	I <sub>b</sub>	- - - -	1.2 2.0 2.5 4.0	3.5 5.0 7.5 10	μA
	Input Offset Current (I <sub>io</sub> = I <sub>1</sub> - I <sub>2</sub> ) (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc) (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, T <sub>A</sub> = -55 to +125°C) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, T <sub>A</sub> = -55 to +125°C)	I <sub>io</sub>	- - - -	0.1 - 0.2 -	0.5 1.5 0.5 1.5	μA
	Input Offset Voltage $R_S = 2.0 \text{ k}\Omega$ (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc) (V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc, T <sub>A</sub> = -55°C, +125°C) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc) (V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc, T <sub>A</sub> = -55°C, +125°C)	V <sub>io</sub>	- - - -	1.3 - 1.1 -	3.0 4.0 2.0 3.0	mV
	Step Response V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc Gain = 100, V <sub>in</sub> = 1.0 mV, R <sub>1</sub> = 1.0 kΩ, R <sub>2</sub> = 100 kΩ, C <sub>2</sub> = 50 pF, R <sub>3</sub> = ∞, C <sub>1</sub> = open V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc Gain = 1.0, V <sub>in</sub> = 10 mV, R <sub>1</sub> = 10 kΩ, R <sub>2</sub> = 10 kΩ, C <sub>1</sub> = 0.01 μF, R <sub>3</sub> = 20Ω, C <sub>2</sub> = open	V <sub>os</sub> t <sub>f</sub> t <sub>pd</sub> dV <sub>out</sub> /dt <sup>②</sup> V <sub>f</sub> t <sub>f</sub> t <sub>pd</sub> dV <sub>out</sub> /dt <sup>②</sup>	- - - - - - - -	20 10 10 12 10 25 16 1.5	40 30 - - 50 120 - -	% ns ns V/μs % ns ns V/μs
	Average Temperature Coefficient of Input Offset Voltage $R_S = 50 \Omega$ (T <sub>A</sub> = +25 to +125°C) (T <sub>A</sub> = -55 to +25°C)	TC <sub>Vio</sub>	- -	2.5 2.0	- -	μV/°C
	Average Temperature Coefficient Input Offset Current (T <sub>A</sub> = +25°C to +125°C) (T <sub>A</sub> = -55 to +25°C)	TC <sub>Iio</sub>	- -	0.05 1.5	- -	nA/°C
	DC Power Dissipation (V <sub>out</sub> = 0, V <sup>+</sup> = 6.0 Vdc, V <sup>-</sup> = -3.0 Vdc) (V <sub>out</sub> = 0, V <sup>+</sup> = 12 Vdc, V <sup>-</sup> = -6.0 Vdc)	P <sub>D</sub>	- -	17 70	30 120	mW
	Positive Supply Sensitivity (V <sup>-</sup> constant = -6.0 Vdc, V <sup>+</sup> = 12 Vdc to 6.0 Vdc) Negative Supply Sensitivity (V <sup>+</sup> constant = 12 Vdc, V <sup>-</sup> = -6.0 Vdc to -3.0 Vdc)	S <sup>+</sup> S <sup>-</sup>	- -	80 60	200 200	μV/V μV/V

① All definitions imply linear operation. ② dV<sub>out</sub>/dt = Slew Rate

TYPICAL OUTPUT CHARACTERISTICS

$V_+ = 12 \text{ Vdc}$ ,  $V_- = -6.0 \text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$

FIGURE 1 — OPEN LOOP GAIN versus POWER SUPPLY VARIATIONS

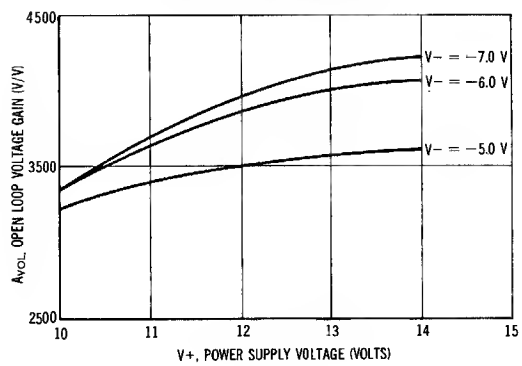


FIGURE 2 — OPEN LOOP VOLTAGE GAIN versus FREQUENCY

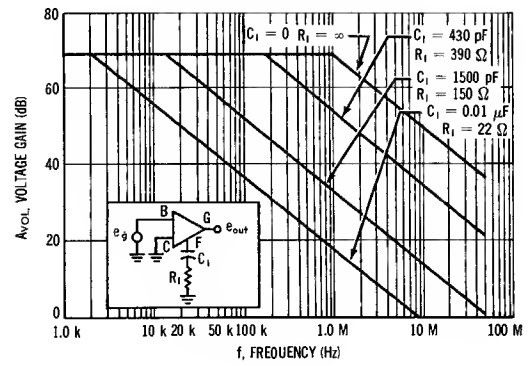


FIGURE 3 — VOLTAGE GAIN versus FREQUENCY

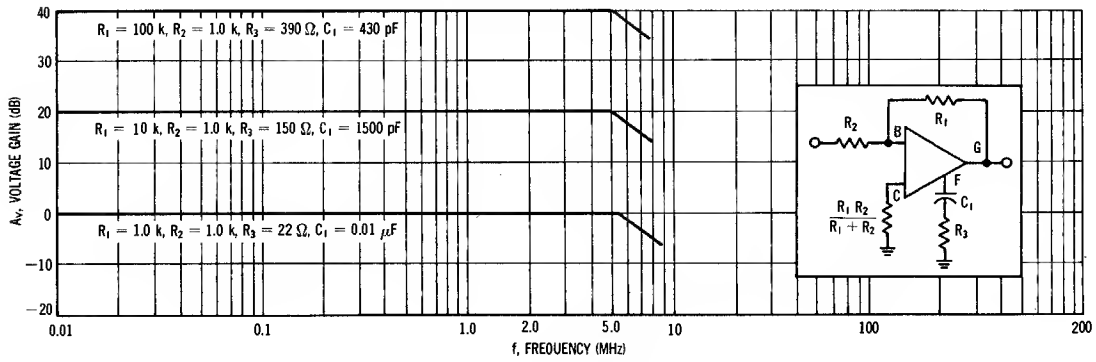


FIGURE 4 — MAXIMUM OUTPUT SWING versus FREQUENCY

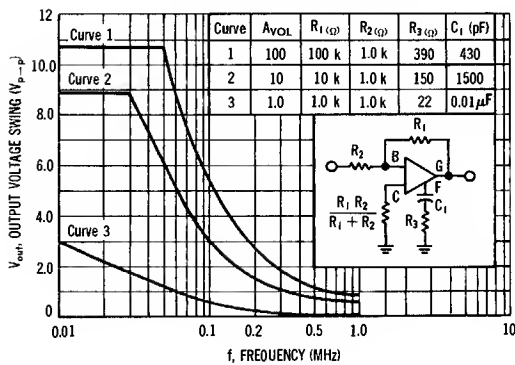


FIGURE 5 — OUTPUT VOLTAGE SWING versus LOAD RESISTANCE

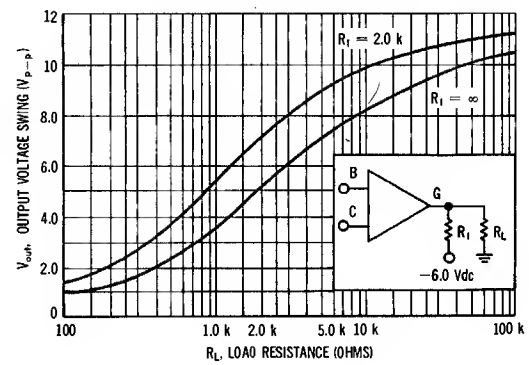
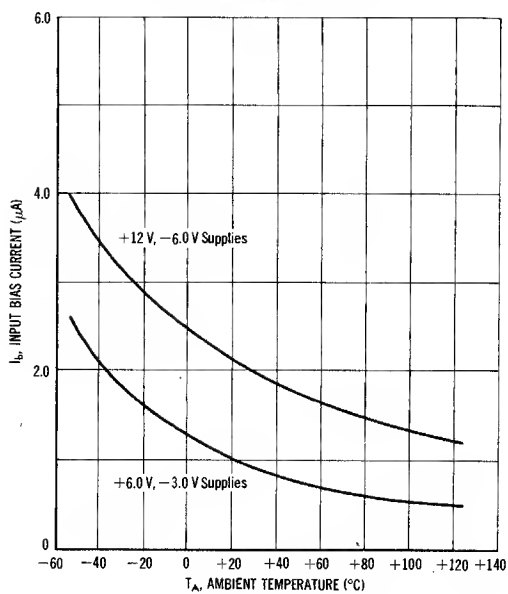
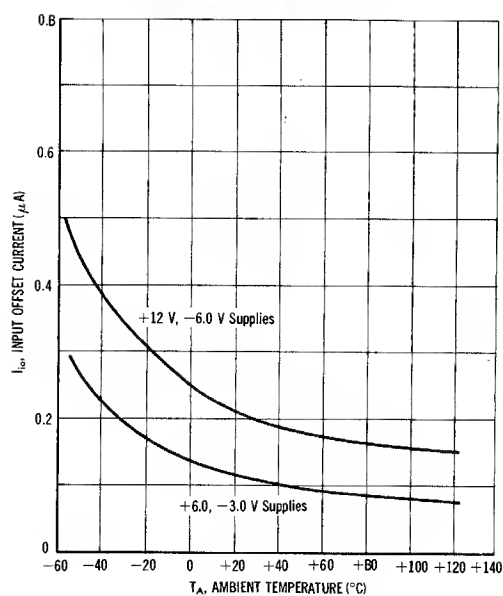
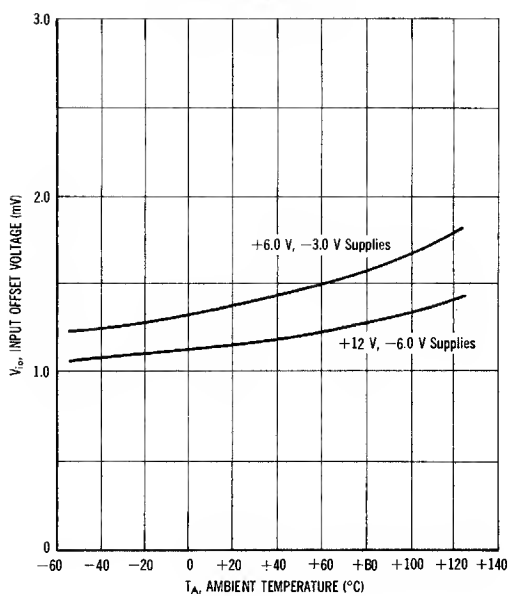
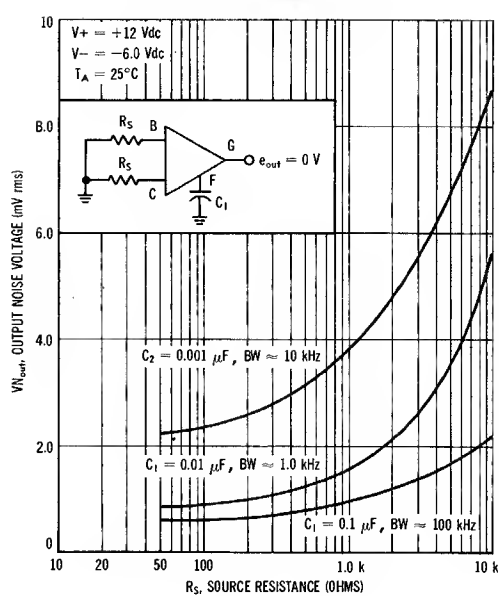
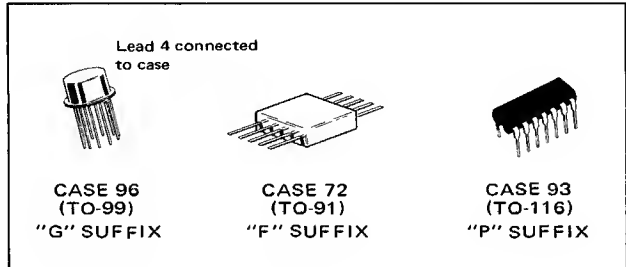


FIGURE 6 — INPUT BIAS CURRENT  
versus TEMPERATUREFIGURE 7 — INPUT OFFSET CURRENT  
versus TEMPERATUREFIGURE 8 — INPUT OFFSET VOLTAGE  
versus TEMPERATUREFIGURE 9 — OUTPUT NOISE VOLTAGE  
versus SOURCE IMPEDANCE

# MC1712C

... designed for use as an operational amplifier utilizing operating characteristics as a function of the external feedback components.



## Typical Amplifier Features:

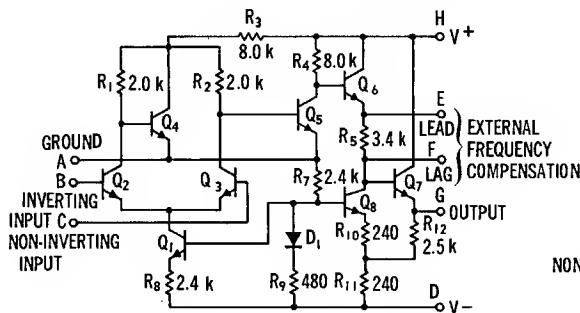
- Open Loop Gain  $A_{VOL} = 3400$  typical
- Low Temperature Drift —  $\pm 5.0 \mu V/^\circ C$
- Output Voltage Swing —  $\pm 5.3 V$  typical @ +12 V and -6.0 V Supplies
- Low Output Impedance —  $Z_{out} = 200$  ohms typical

## MAXIMUM RATINGS ( $T_A = 25^\circ C$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage (Total between $V^+$ and $V^-$ terminals)	$ V^+  +  V^- $	21	Vdc
Differential Input Signal	$V_{in}$	$\pm 5.0$	Volts
Common Mode Input Swing	$CMV_{in}$	+1.5 -6.0	Volts
Peak Load Current	$I_L$	50	mA
Power Dissipation (Package Limitation)	$P_D$		
Metal Can		680	mW
Derate above $25^\circ C$		4.6	mW/ $^\circ C$
Flat Package		500	mW
Derate above $25^\circ C$		3.3	mW/ $^\circ C$
Plastic Package		400	mW
Derate above $25^\circ C$		3.3	mW/ $^\circ C$
Operating Temperature Range*	$T_A$	0 to +75	$^\circ C$
Storage Temperature Range	$T_{stg}$		
Metal Can and Flat Package		-65 to +150	$^\circ C$
Plastic Package		-55 to +125	$^\circ C$

\* For full temperature range ( $-55^\circ C$  to  $+125^\circ C$ ) and characteristic curves, see MC1712 data sheet.

## CIRCUIT SCHEMATIC

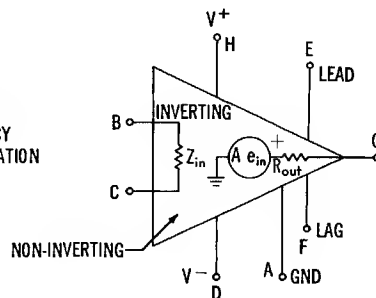


### PIN CONNECTIONS

Schematic	A	B	C	D	E	F	G	H
"G" Package	1	2	3	4	5	6	7	8
"F" Package	2	3	4	5	6	7	8	10
"P" Package	3	4	5	6	9	10	12	13

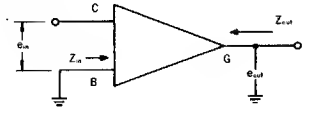

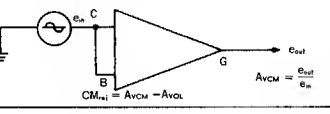

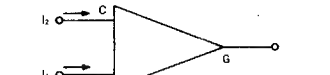

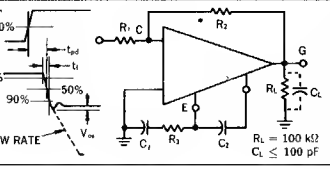
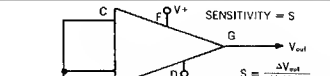
\* Pin 7 is electrically connected to substrate and to  $V^-$

## EQUIVALENT CIRCUIT



# MC1712C (continued)

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic Definitions ①	Characteristic	Symbol	Min	Typ	Max	Unit
 <p><math>A_{VOL} = \frac{e_{out}}{e_{in}}</math></p>	<p>Open Loop Voltage Gain <math>R_L = 100 \text{ k}\Omega</math>  <math>(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, V_{out} = \pm 2.5 \text{ V})</math>  <math>(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, V_{out} = \pm 5.0 \text{ V})</math>  <math>(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, V_{out} = \pm 5.0 \text{ Vdc}, T_A = 0, +75^\circ\text{C})</math>  <math>(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, V_{out} = \pm 2.5 \text{ V}, T_A = 0, +75^\circ\text{C})</math></p>	$A_{VOL}$	500 2000 1500 400	800 3400 - -	1500 6000 7000 1750	V/V
	Output Impedance $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, f = 20 \text{ Hz})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, f = 20 \text{ Hz})$	$Z_{out}$	- -	300 200	800 600	ohms
	Input Impedance $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, f = 20 \text{ Hz})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, f = 20 \text{ Hz})$	$Z_{in}$	16 10	55 32	- -	k ohms
	Output Voltage Swing $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, R_L = 100 \text{ k}\Omega)$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, R_L = 100 \text{ k}\Omega)$ $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, R_L = 10 \text{ k}\Omega)$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, R_L = 10 \text{ k}\Omega)$	$V_{out}$	$\pm 2.5$ $\pm 5.0$ $\pm 1.5$ $\pm 3.5$	$\pm 2.7$ $\pm 5.3$ $\pm 2.0$ $\pm 4.0$	- - - -	V <sub>peak</sub>
 <p><math>CM_{in} = A_{VOL} - A_{VOL}</math></p>	Input Common Mode Voltage Swing $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc})$	$CMV_{in}$	$+0.5$ $-1.5$ $+0.5$ $-4.0$	- - - -	- - - -	V <sub>peak</sub>
	Common Mode Rejection Ratio $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, f = 1.0 \text{ kHz})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, f = 1.0 \text{ kHz})$	$CM_{rej}$	70 70	95 95	- -	dB
	Input Bias Current $T_A = 25^\circ\text{C}$ $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc})$ $T_A = 0^\circ\text{C to } +75^\circ\text{C}$ $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc})$ $T_A = 0^\circ\text{C to } -75^\circ\text{C}$	$I_b$	- - - -	1.5 2.5 2.5 4.0	5.0 7.5 8.0 12	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ ) $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, T_A = 0^\circ\text{C to } +75^\circ\text{C})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, T_A = 0^\circ\text{C to } +75^\circ\text{C})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, T_A = 0^\circ\text{C to } -75^\circ\text{C})$	$I_{io}$	- - - -	0.3 - 0.5 2.5	2.0 2.5 2.0 2.5	$\mu\text{A}$
	Input Offset Voltage $R_S = 2.0 \text{ k}\Omega$ $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc})$ $(V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc}, T_A = 0^\circ\text{C to } +75^\circ\text{C})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc})$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc}, T_A = 0^\circ\text{C to } -75^\circ\text{C})$	$V_{io}$	- - - -	1.7 - 1.5 -	6.0 7.5 5.0 6.5	mV
 <p>SLEW RATE</p>	Step Response $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc})$ $\text{Gain} = 100, V_{in} = 1.0 \text{ mV}$ $R_1 = 1.0 \text{ k}\Omega, R_2 = 100 \text{ k}\Omega$ $C_2 = 50 \text{ pF}, R_3 = \infty, C_1 = \text{open}$ $(V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc})$ $\text{Gain} = 1.0, V_{in} = 10 \text{ mV}$ $R_1 = 10 \text{ k}\Omega, R_2 = 10 \text{ k}\Omega$ $C_1 = 0.01 \text{ }\mu\text{F}, R_3 = 20 \Omega, C_2 = \text{open}$	$V_{os}$ $t_f$ $t_{pd}$ $\frac{dV_{out}}{dt}$ ② $V_{os}$ $t_f$ $t_{pd}$ $\frac{dV_{out}}{dt}$ ②	- - - - - - - -	20 10 10 12 10 25 16 1.5	40 30 - - 50 120 - -	% ns ns V/ $\mu\text{s}$ % ns ns V/ $\mu\text{s}$
	Average Temperature Coefficient of Input Offset Voltage $R_S = 50 \Omega$ $(T_A = 0, +75^\circ\text{C})$	$TC_{V_{io}}$	-	5.0	-	$\mu\text{V}/^\circ\text{C}$
	Average Temperature Coefficient Input Offset Current $(T_A = +25^\circ\text{C to } +75^\circ\text{C})$ $(T_A = 0 \text{ to } +25^\circ\text{C})$	$TC_{I_{io}}$	- -	4.0 6.0	- -	nA/ $^\circ\text{C}$
	DC Power Dissipation $(V_{out} = 0, V^+ = 6.0 \text{ Vdc}, V^- = -3.0 \text{ Vdc})$ $(V_{out} = 0, V^+ = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc})$	$P_D$	- -	17 70	30 120	mW
	Positive Supply Sensitivity $(V^- \text{ constant} = -6.0 \text{ Vdc}, V^+ = 12 \text{ Vdc to } 6.0 \text{ Vdc})$ Negative Supply Sensitivity $(V^+ \text{ constant} = 12 \text{ Vdc}, V^- = -6.0 \text{ Vdc to } -3.0 \text{ Vdc})$	$S^+$ $S^-$	- -	60 60	300 300	$\mu\text{V}/\text{V}$ $\mu\text{V}/\text{V}$

① All definitions imply linear operation. ②  $dV_{out}/dt$  = Slew Rate



# EMITTER COUPLED AMPLIFIER

# HIGH FREQUENCY AMPLIFIERS

## MC1110

### Typical Amplifier Features:

- DC — 300 MHz Performance
- Intended for IF and RF Applications
- 26 dB typ. Gain at 100 MHz
- High Stability Through Low Internal Feedback

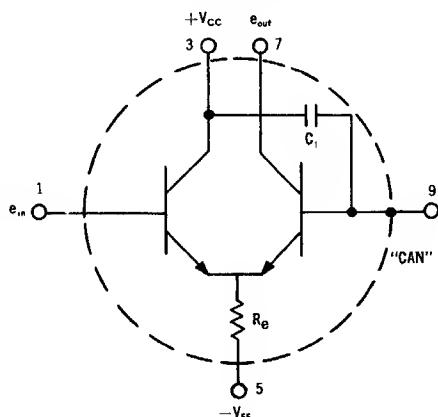


CASE 89

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V_{CC}$	10	Vdc
Power Supply Voltage	$V_{EE}$	14	Vdc
Total Power Dissipation (Derate 5 mW/ $^\circ\text{C}$ above $T_A = 25^\circ\text{C}$ )	$P_D$	0.5	Watt
Operating Temperature Range	$T_j$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +200	$^\circ\text{C}$
Maximum Input Level (RMS)	$V_{in}$	2	V (RMS)

### CIRCUIT SCHEMATIC



### CIRCUIT DESCRIPTION

#### CIRCUIT OPERATION

The input terminal (Pin 1) of the device should be DC ground for optimum DC operating point. Pin 3 is to be supplied with a positive voltage ( $V_{CC}$ ) for transistor collector and Pin 5 with a negative voltage ( $V_{EE}$ ) to supply emitter bias current. AGC may be accomplished by variation of  $V_{EE}$ . The output of the circuit (Pin 7) should be operated at the same DC potential as is Pin 3. Pin 9 should be AC and DC grounded. Resistor  $R_e$  is a diffused silicon resistor, and  $C_1$  is a silicon oxide capacitor.

**ELECTRICAL CHARACTERISTICS** (at  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>DC CHARACTERISTICS</b>					
Input Leakage Current ( $V_3 = 5\text{ Vdc}$ ; $I_5, I_7, I_9 = 0$ )	$I_1$	---	---	10	nAdc
Output Leakage Current ( $V_7 = 5\text{ Vdc}$ ; $I_1, I_3, I_5 = 0$ )	$I_9$	---	---	10	nAdc
Operating Current ( $V_{CC} = 5\text{ Vdc}$ , $V_{EE} = -4.7\text{ Vdc}$ , $V_{in} = 0$ )	$I_{CT}$	3.8	4	4.2	mAdc
Input Operating Current $V_{CC} = 5\text{ Vdc}$ , ( $V_{EE} = -10\text{ Vdc}$ , $V_{in} = 0$ )	$I_1$	---	---	250	$\mu\text{Adc}$
Reference Operating Current $V_{CC} = 5\text{ Vdc}$ , ( $V_{EE} = -10\text{ Vdc}$ , $V_{in} = 0$ )	$I_9$	---	---	250	$\mu\text{Adc}$
Current Balance $V_{CC} = 5\text{ Vdc}$ , ( $V_{EE} = -10\text{ Vdc}$ , $V_{in} = 0$ ) $V_{CC} = 5\text{ Vdc}$ , $V_{EE} = -4.7\text{ Vdc}$ , $V_{in} = 0$ )	$I_3/I_7$	0.90 0.90	---	1.10 1.10	---
Large Signal Transconductance ( $V_{CC} = 5\text{ Vdc}$ , $V_{EE} = -4\text{ Vdc}$ , $\Delta V_{in} = 50\text{ mV}$ )	$G_{21}$	26	28	---	m-mhos

**SMALL-SIGNAL CHARACTERISTICS**

Small Signal Current Gain ( $V_{CC} = 5\text{ V}$ , $I_E = -4\text{ mA}$ , $f = 100\text{ MHz}$ )	$h_{21}$	6.0	9.0	---	---
Short Circuit Admittances ( $V_{CC} = 5\text{ V}$ , $V_{EE} = -4\text{ V}$ , $f = 100\text{ MHz}$ )	---	---	---	---	m-mhos
Input Admittance	$ Y_{11} $	---	2.0	---	
Reverse Transfer Admittance	$ Y_{12} $	---	0.064	---	
Forward Transfer Admittance	$ Y_{21} $	---	16.3	---	
Output Admittance	$ Y_{22} $	---	1.2	---	
Transducer Power Gain ( $V_{CC} = 5\text{ V}$ , $V_{EE} = -4\text{ V}$ , $f = 100\text{ MHz}$ , $BW = 3\text{ MHz}$ ) ( $V_{CC} = 5\text{ V}$ , $V_{EE} = -4\text{ V}$ , $f = 200\text{ MHz}$ , $BW = 6\text{ MHz}$ )	$G_T$	22 15	26 18	---	dB
Noise Figure ( $V_{CC} = 5\text{ V}$ , $V_{EE} = -4\text{ V}$ , $f = 100\text{ MHz}$ , $R_g = R_{SO}$ )	NF	---	4	6	dB

FIGURE 1 — DC CHARACTERISTICS TEST CIRCUIT

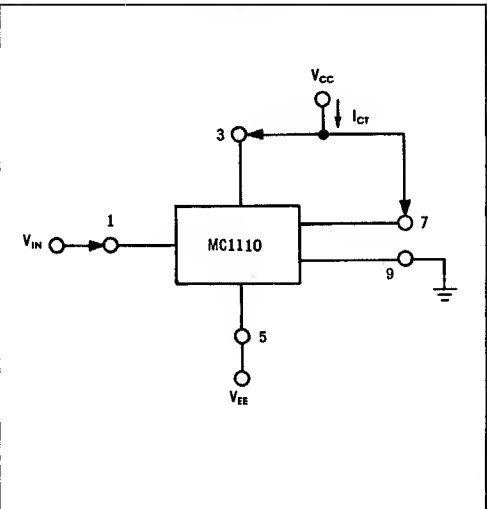
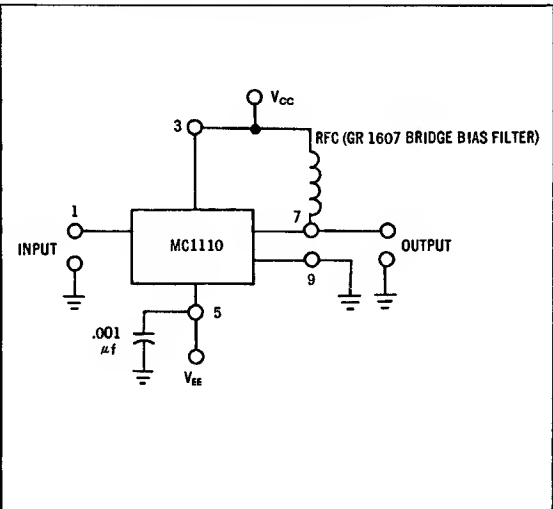


FIGURE 2 — SHORT CIRCUIT ADMITTANCE TEST CIRCUIT  
(GENERAL RADIO 1607 A BRIDGE)



# MC1110 (continued)

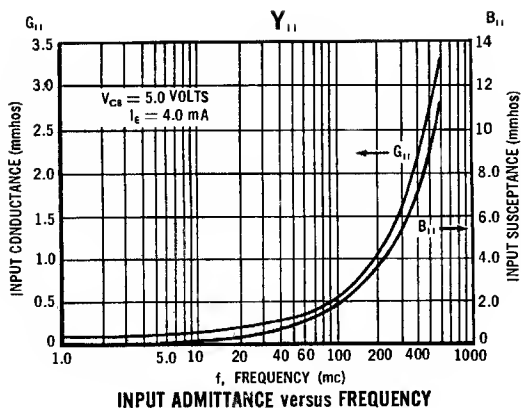


FIGURE 3

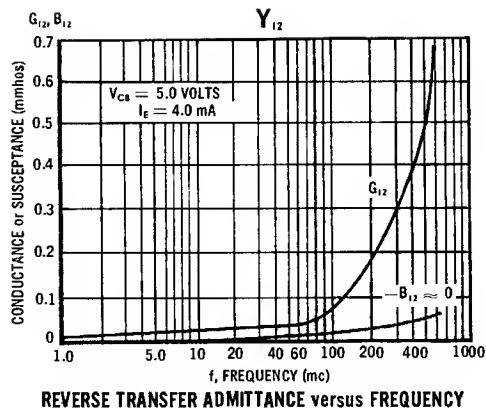


FIGURE 6

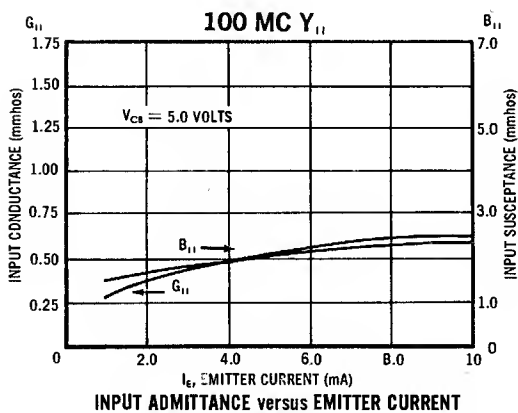


FIGURE 4

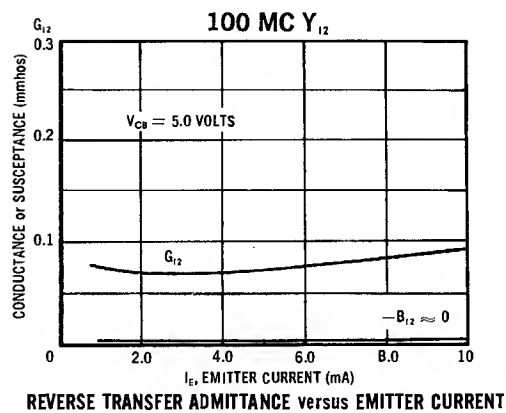


FIGURE 7

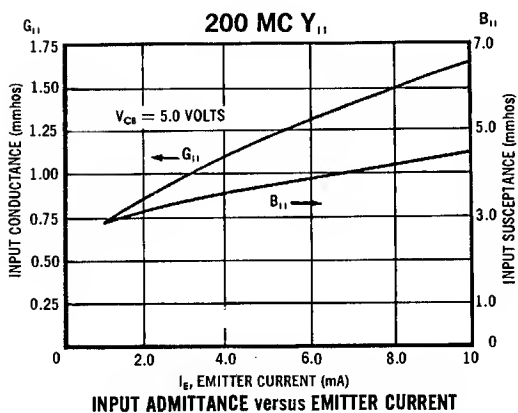


FIGURE 5

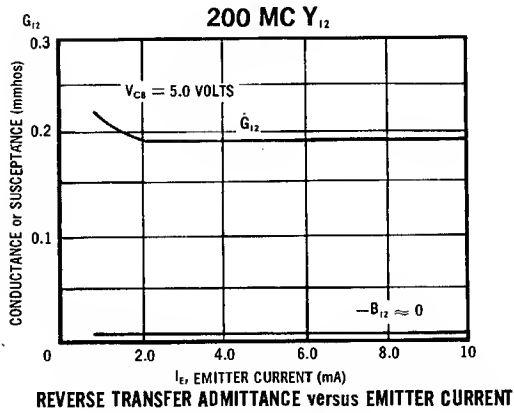


FIGURE 8

# MC1110 (continued)

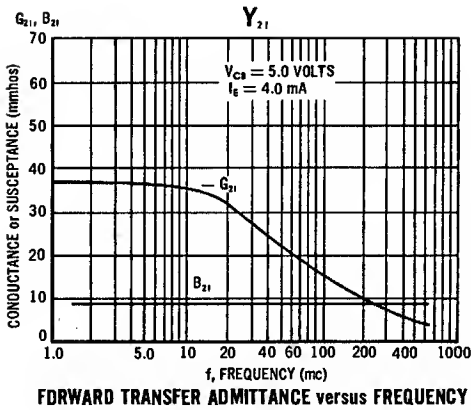


FIGURE 9

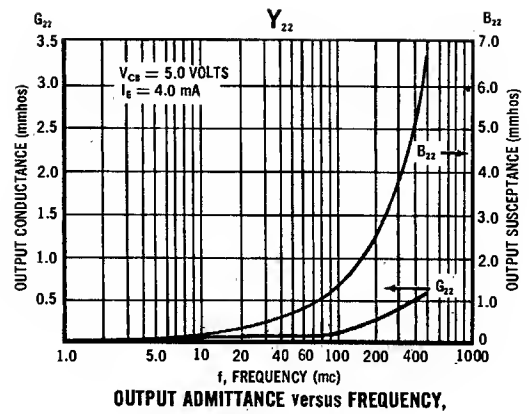


FIGURE 12

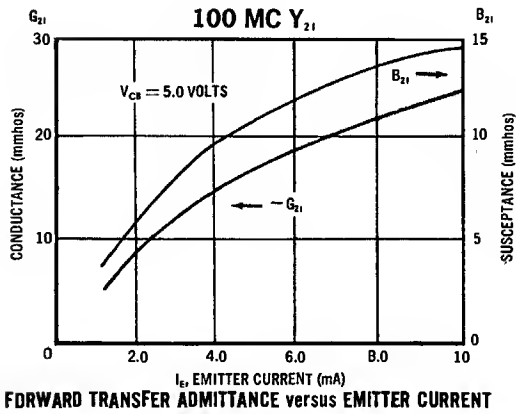


FIGURE 10

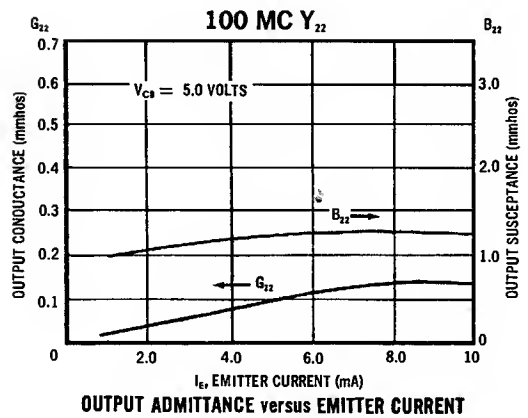


FIGURE 13

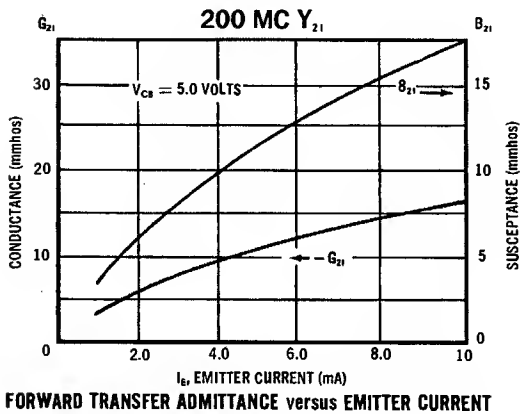


FIGURE 11

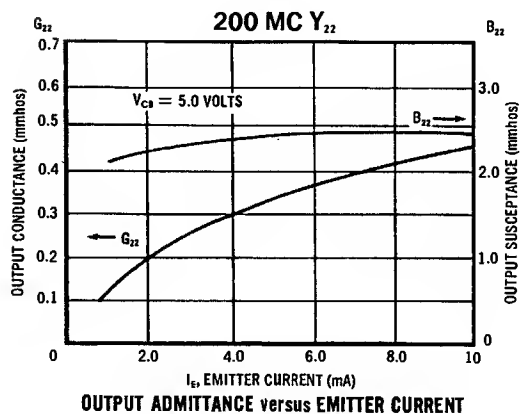
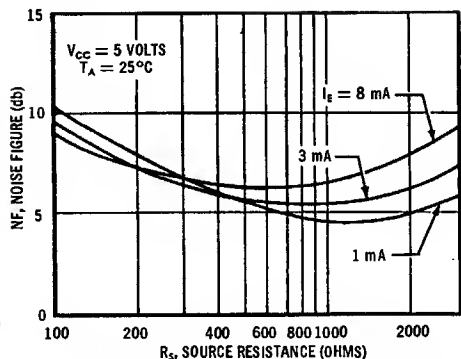


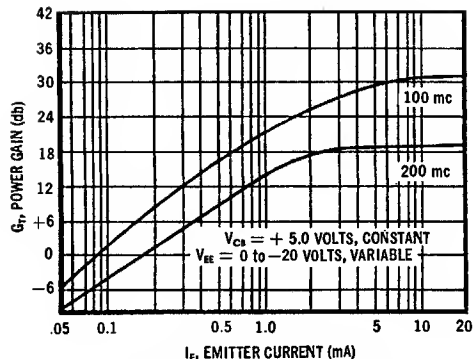
FIGURE 14

# MC1110 (continued)



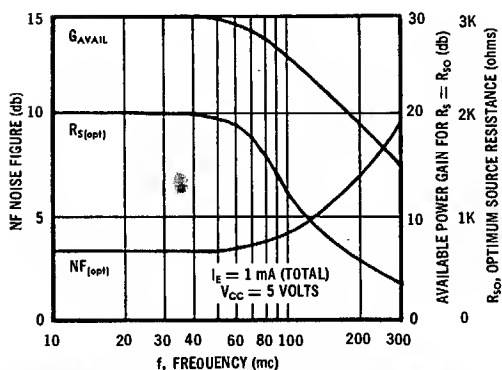
100 MC NOISE FIGURE VS. SOURCE RESISTANCE

FIGURE 15



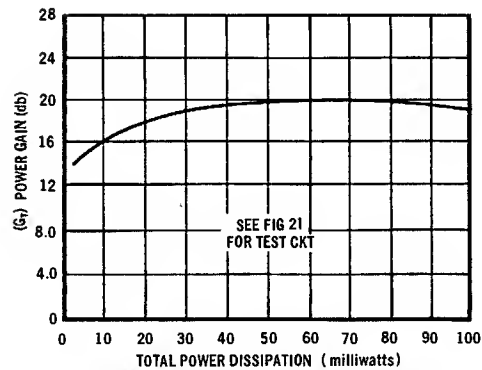
GAIN CONTROL CHARACTERISTICS

FIGURE 16



OPTIMUM NOISE FIGURE, OPTIMUM SOURCE RESISTANCE, AND AVAILABLE POWER GAIN VS. FREQUENCY

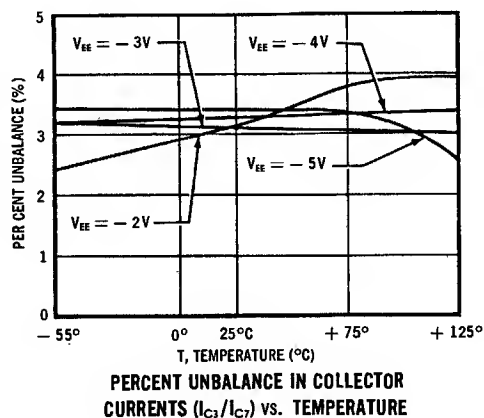
FIGURE 17



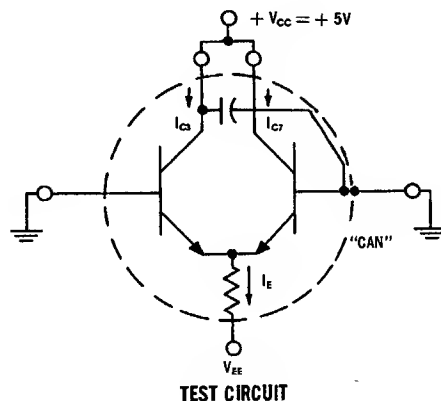
200 MC TRANSDUCER POWER GAIN ( $G_T$ ) VS. POWER DISSIPATION

FIGURE 18

FIGURE 19



PERCENT UNBALANCE IN COLLECTOR CURRENTS ( $I_{C1}/I_{C7}$ ) VS. TEMPERATURE



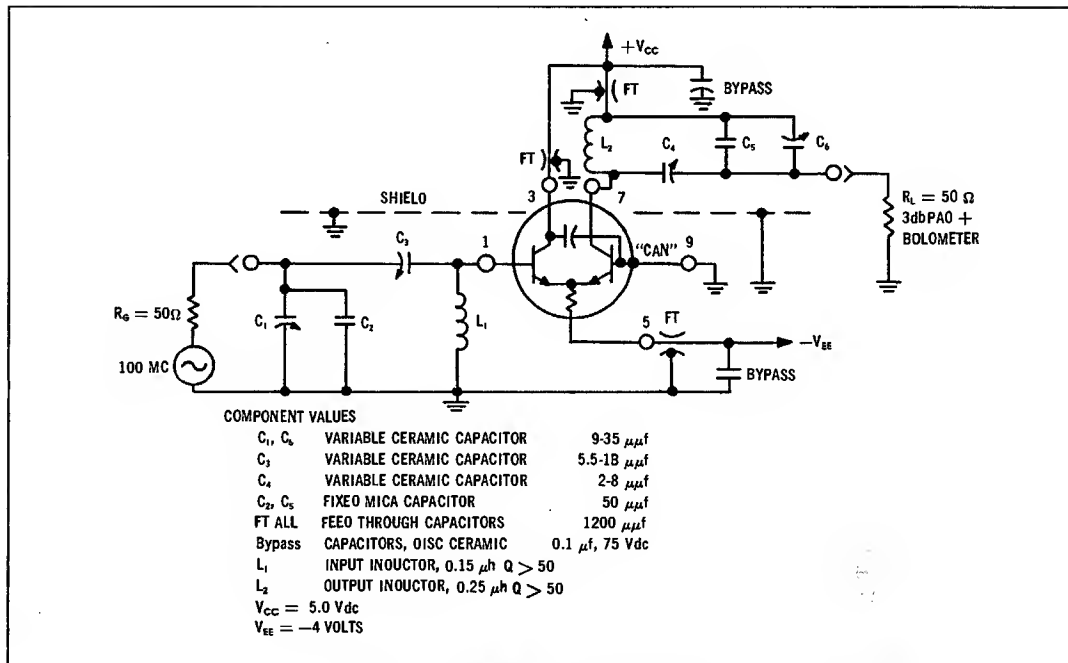


FIGURE 20 — 100 MC POWER GAIN TEST SET

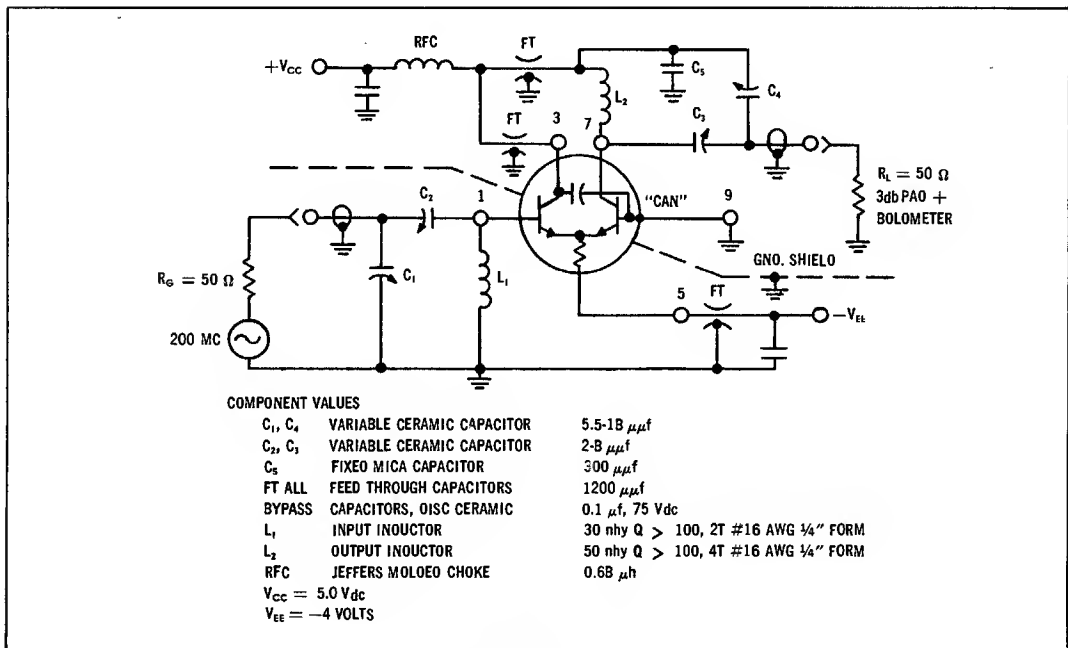


FIGURE 21 — 200 MC POWER GAIN TEST SET

## VIDEO AMPLIFIER

## HIGH FREQUENCY AMPLIFIERS

### MC1510 MC1509

... designed for use as a high-frequency differential amplifier with operating characteristics that provide a flat frequency response from dc to 40 MHz.

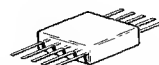
#### Typical Amplifier Features:

- High Gain Characteristics  
A<sub>v</sub> = 93 typical
- Wide Bandwidth — dc to 40 MHz
- Large Output Voltage Swing —  
4.5 V p-p typical @ ±6.0 V Supply
- Low Output Distortion —  
THD ≤ 1.5%



Lead 4 connected to case

CASE 96  
(TO-99)  
MC1510G



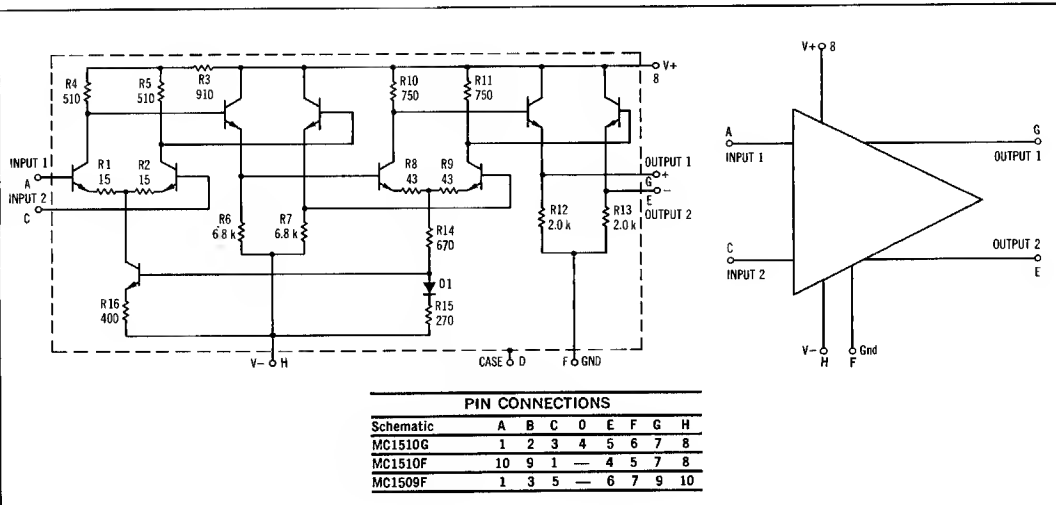
CASE 73  
(TO-90)  
MC1510F  
MC1509F

#### MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	V <sup>+</sup>	+8.0	Vdc
	V <sup>-</sup>	-8.0	Vdc
Differential Input Signal	V <sub>in</sub>	± 5.0	Volts
Common Mode Input Swing	CMV <sub>in</sub>	± 6.0	Volts
Load Current	I <sub>L</sub>	10	mA
Output Short Circuit Duration	t <sub>S</sub>	5.0	s
Power Dissipation (Package Limitation)	P <sub>D</sub>	680	mW
		4.6	mW/°C
		500	mW
		3.3	mW/°C
Operating Temperature Range	T <sub>A</sub>	-55 to +125	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

#### CIRCUIT SCHEMATIC

#### EQUIVALENT CIRCUIT



# MC1510, MC1509 (continued)

ELECTRICAL CHARACTERISTICS (V+ = +6 Vdc, V- = -6 Vdc, TA = 25°C unless otherwise noted)

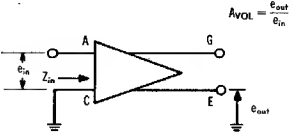
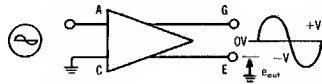
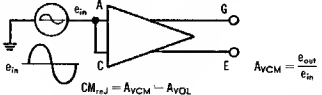
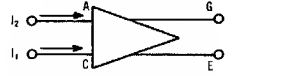
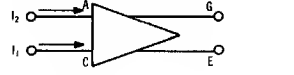
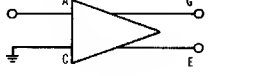
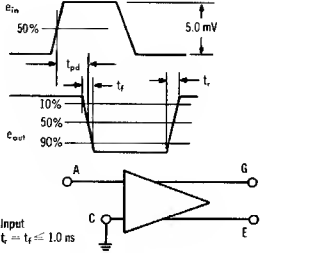
Characteristic Definitions	Characteristic	Symbol	Min	Typ	Max	Unit
 $A_{VOL} = \frac{e_{out}}{e_{in}}$	Single Ended Voltage Gain	$A_{V(se)}$	75	93	110	-
	Output Impedance (f = 20 kHz)	$Z_{out}$	-	35	-	$\Omega$
	Input Impedance (f = 20 kHz)	$Z_{in}$	-	6.0	-	k $\Omega$
	Bandwidth (-3.0 dB)	BW	-	40	-	MHz
	Output Voltage Swing ( $R_L = 5.0 \text{ k}\Omega$ , f = 100 kHz)	$V_{out}$	-	4.5	-	Vp-p
	Single Ended Output Distortion ( $e_{in} < 0.2\%$ Distortion)	THD	-	1.5	5.0	%
 $CM_{rej} = A_{VCM} - A_{VOL}$ $A_{VCM} = \frac{e_{out}}{e_{in}}$	Input Common Mode Voltage Swing	$CMV_{in}$	-	$\pm 1.0$	-	V <sub>peak</sub>
	Common Mode Voltage Gain ( $R_L = 5 \text{ k}\Omega$ , $e_{in} = 0.3 \text{ V rms}$ , f = 100 kHz)	$A_{VCM}$	-30	-45	-	dB
	Common Mode Rejection Ratio	$CM_{rej}$	-	-85	-	
	Input Bias Current $\left( I_b = \frac{I_1 + I_2}{2} \right)$ Differential Output = 0	$I_b$	-	20	80	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ )	$I_{io}$	-	3.0	20	$\mu\text{A}$
	Output Offset Voltage Differential Mode ( $V_{in} = 0$ )	$V_{out(DM)}$	-	0.5	1.3	Vdc
	Common Mode (Differential Output = 0)	$V_{out(CM)}$	2.6	3.1	3.5	
	Step Response	$t_f$ $t_{pd}$ $t_r$	- - -	9.0 9.0 9.0	12 - 12	ns
	Average Temperature Coefficient of Input Offset Voltage ( $R_S = 50 \Omega$ , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ ) ( $R_S \leq 10 \text{ k}\Omega$ , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$TC_{V_{io}}$	- -	3.0 6.0	- -	$\mu\text{V}/^\circ\text{C}$
	DC Power Dissipation (Power Supply = $\pm 6.0 \text{ V}$ )	$P_D$	-	150	220	mW
	Input Noise Voltage (f = 5.0 Hz to 10 MHz)	$V_n$	-	4.5	-	$\mu\text{V}$



FIGURE 1 — VOLTAGE GAIN versus FREQUENCY

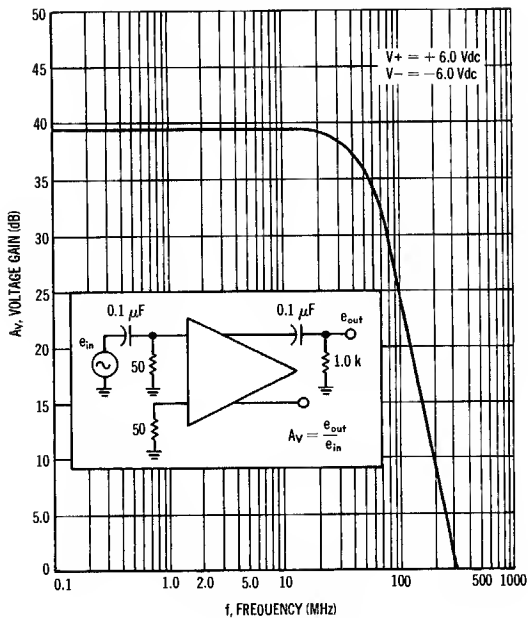


FIGURE 2 — VOLTAGE GAIN versus SUPPLY VOLTAGE

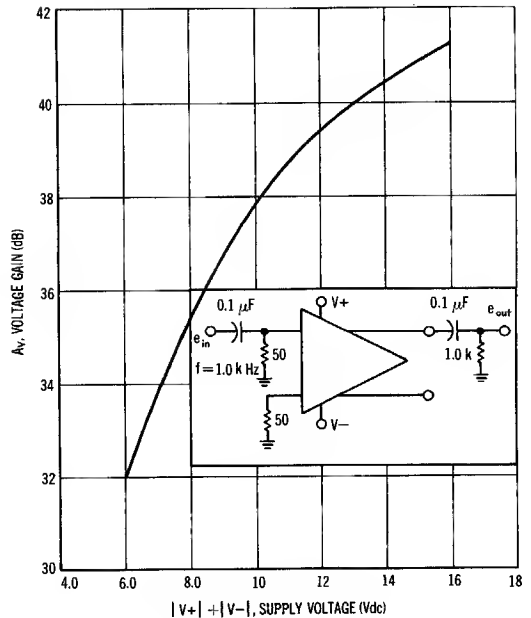


FIGURE 3 — VOLTAGE GAIN versus TEMPERATURE

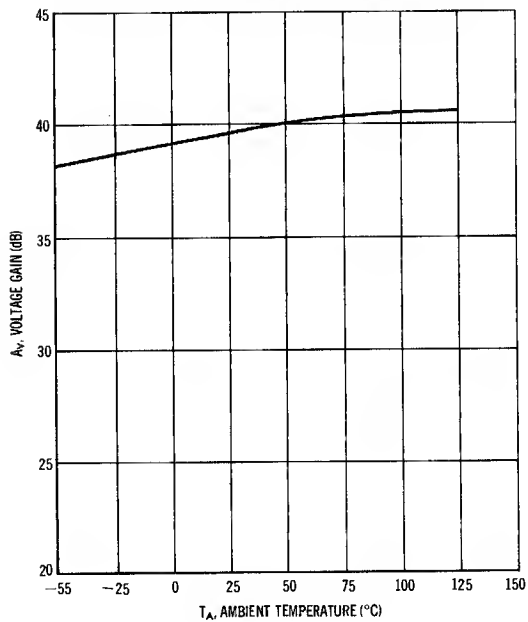
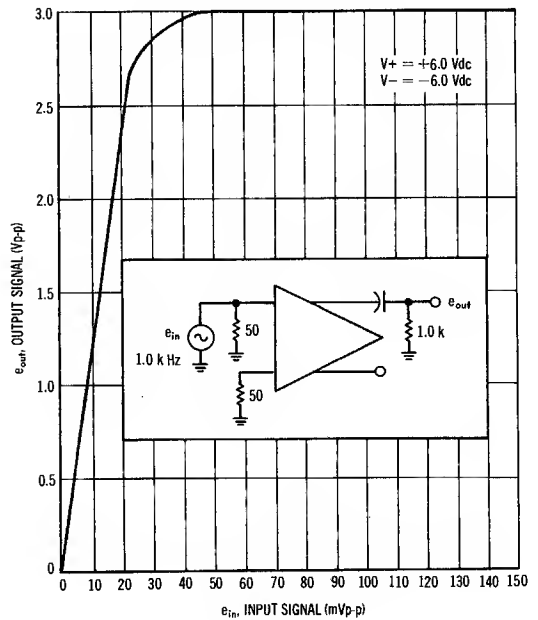


FIGURE 4 — LIMITING CHARACTERISTICS



# MC1510, MC1509 (continued)

FIGURE 5 — DC OUTPUT VOLTAGE versus TEMPERATURE

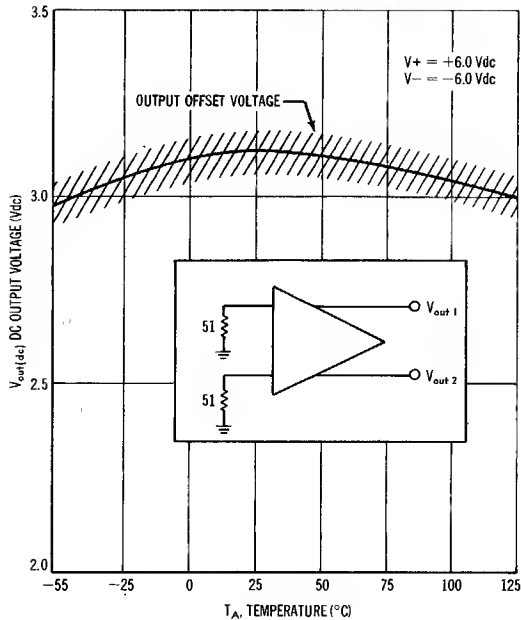


FIGURE 6 — INPUT BIAS CURRENT versus TEMPERATURE

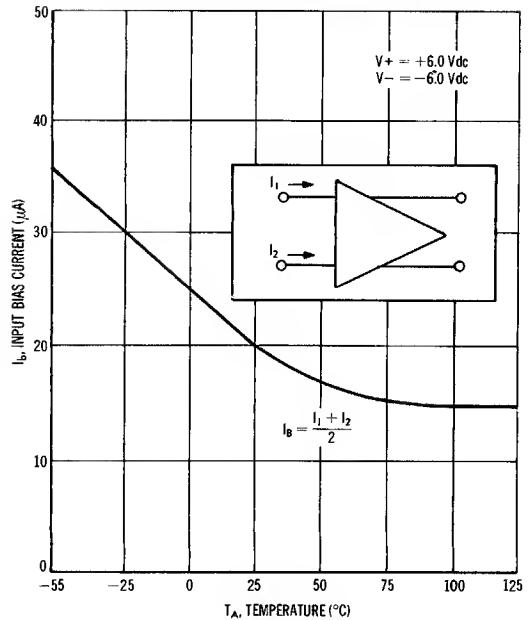


FIGURE 7 — POWER DISSIPATION versus SUPPLY VOLTAGE

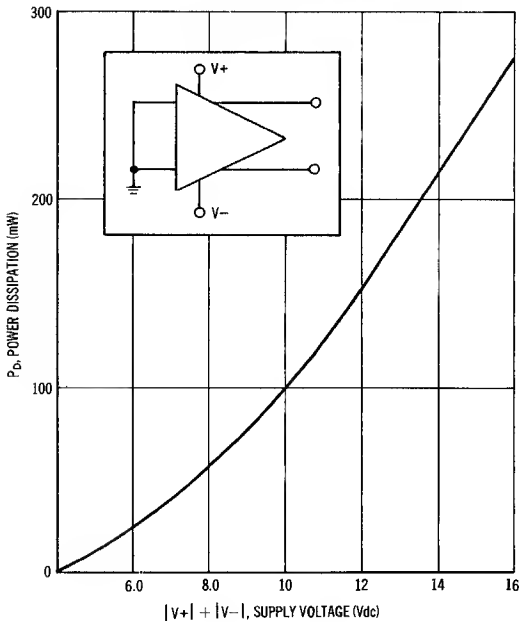
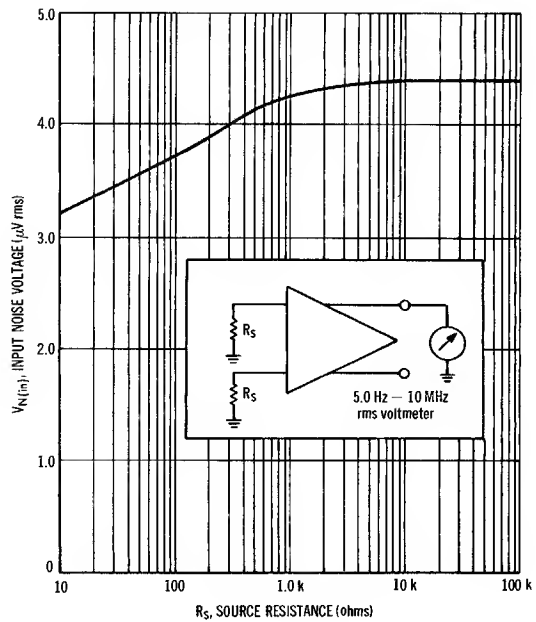


FIGURE 8 — INPUT NOISE VOLTAGE versus SOURCE IMPEDANCE



## RF-IF AMPLIFIER

## HIGH FREQUENCY AMPLIFIERS

### MC1550G

... a versatile, common-emitter, common-base cascode circuit for use in communications applications.

#### Typical Amplifier Features:

- Constant Input Impedance over entire AGC range
- Extremely Low  $y_{12} = 0.001$  mmho
- High Power Gain — 30 dB @ 60 MHz (0.5 MHz BW)
- Good Noise Figure — 5.0 dB @ 60 MHz
- High Voltage-Gain-Bandwidth Product — 2.0 GHz



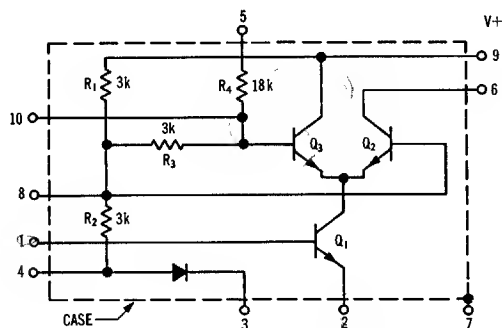
Lead 7 connected to case

CASE 71

#### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage, Pin 9	$V_+$	20	Vdc
AGC Supply Voltage	$V_{AGC}$	20	Vdc
Differential Input Voltage, Pin 1 to Pin 4 ( $R_S = 500$ ohms)	$V_{in}$	$\pm 5$	V (RMS)
Power Dissipation (Package Limitation) Derate above $25^\circ\text{C}$	$P_D$	680 4.6	mW mW/ $^\circ\text{C}$
Operating Temperature Range	$T_A$	$-55$ to $+125$	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	$-65$ to $+150$	$^\circ\text{C}$

#### CIRCUIT SCHEMATIC



#### CIRCUIT DESCRIPTION

The MC1550 is built with monolithic fabrication techniques utilizing diffused resistors and small-geometry transistors. Excellent AGC performance is obtained by shunting the signal through the AGC transistor  $Q_3$ , maintaining the operating point of the input transistor  $Q_1$ . This keeps the input impedance constant over the entire AGC range.

The amplifier is intended to be used in a common-emitter, common-base configuration ( $Q_1$  and  $Q_2$ ) with  $Q_3$  acting as an AGC transistor. The input signal is applied between pins 1 and 4, where pin 4 is ac-coupled to ground. DC source resistance between pins 1 and 4 should be small (less than 100 ohms). Pins 2 and 3 should be connected together and grounded. Pins 8 and 10 should be bypassed to ground. The positive supply voltage is applied at pin 9 and at higher frequencies, pin 9 should also be bypassed to ground. The output is taken between pins 6 and 9. The substrate is connected to pin 7 and should be grounded. AGC voltage is applied to pin 5.

## MC1550G (continued)

### ELECTRICAL CHARACTERISTICS ( $V^+ = +6$ Vdc, $T_A = 25^\circ\text{C}$ )

Characteristic	Conditions	Figure	Symbol	Min	Typ	Max	Unit
<b>DC CHARACTERISTICS</b>							
Output Voltage	$V_{AGC} = 0$ Vdc $V_{AGC} = +6$ Vdc	1	$V_{out}$	3.80 5.90	— —	4.65 8.00	Vdc
Test Voltage	$V_{AGC} = 0$ Vdc $V_{AGC} = +6$ Vdc	1	$V_8$	2.85 3.25	— —	3.40 3.80	Vdc
Supply Drain Current	$V_{AGC} = 0$ Vdc $V_{AGC} = +6$ Vdc	1	$I_D$	— —	— —	2.2 2.5	mAdc
AGC Supply Drain Current	$V_{AGC} = 0$ Vdc $V_{AGC} = +6$ Vdc	1	$I_{AGC}$	— —	— —	-0.2 0.18	mAdc

### SMALL-SIGNAL CHARACTERISTICS

Small-Signal Voltage Gain	$f = 500$ kHz	2	$A_V$	22	—	29	dB
Bandwidth	-3.0 dB	2	BW	22	—	—	MHz
Transducer Power Gain	$f = 60$ MHz, BW = 6 MHz $f = 100$ MHz, BW = 6 MHz	3	$A_P$	—	25 21	—	dB

FIGURE 1 — DC CHARACTERISTICS TEST CIRCUIT

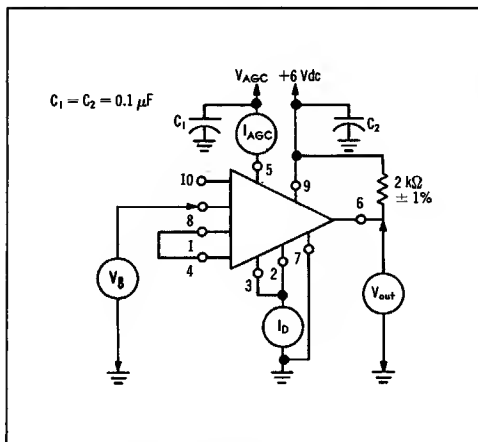


FIGURE 2 — VOLTAGE GAIN AND BANDWIDTH TEST CIRCUIT

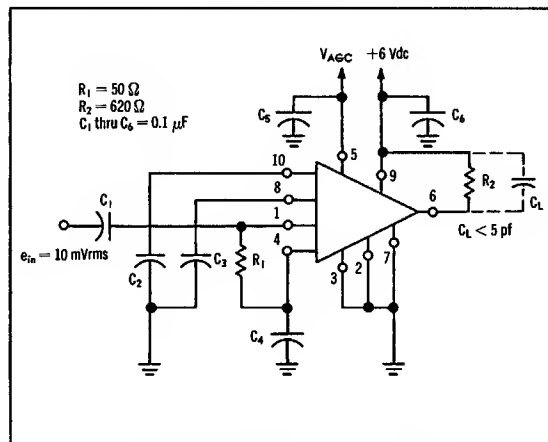


FIGURE 3 — POWER GAIN TEST CIRCUIT @ 60 MHz

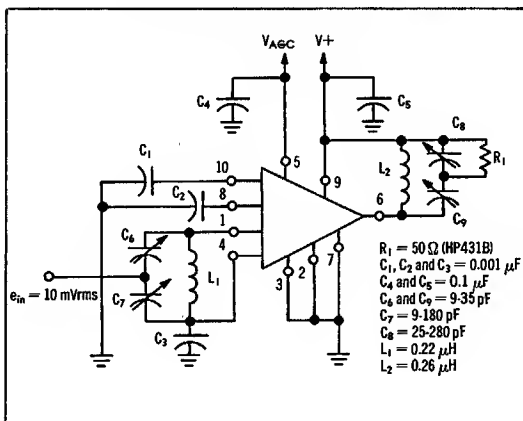


FIGURE 4 — DRAIN CURRENT TEMPERATURE CHARACTERISTICS

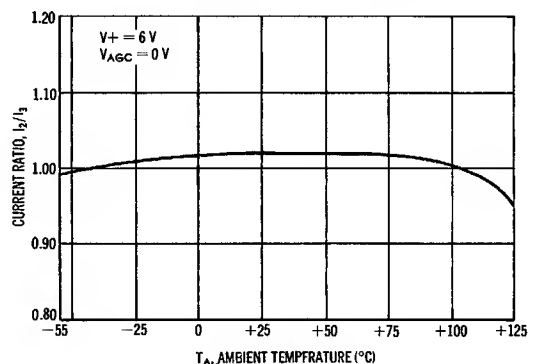


FIGURE 5 — INPUT RESISTANCE AND CAPACITANCE  
versus FREQUENCY

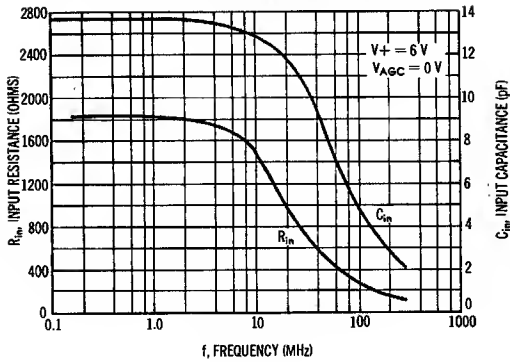


FIGURE 6 — INPUT RESISTANCE AND  
CAPACITANCE versus AGC VOLTAGE

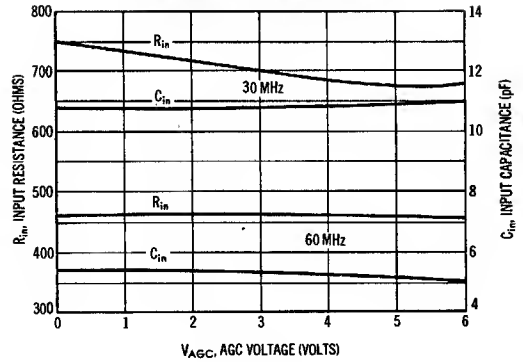


FIGURE 7 — OUTPUT RESISTANCE AND CAPACITANCE  
versus FREQUENCY

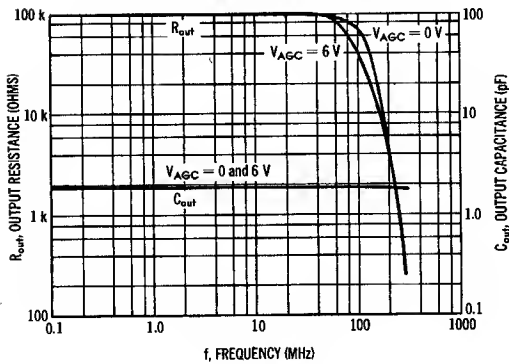


FIGURE 8 — OUTPUT RESISTANCE AND  
CAPACITANCE versus AGC VOLTAGE

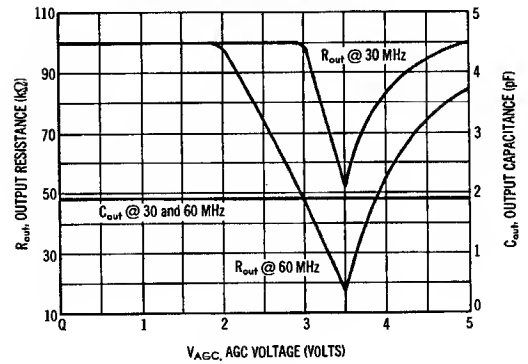


FIGURE 9 — FORWARD TRANSFER ADMITTANCE  
versus FREQUENCY

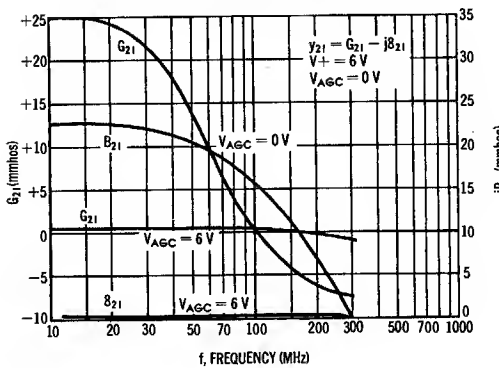


FIGURE 10 — FORWARD TRANSFER ADMITTANCE  
versus AGC VOLTAGE

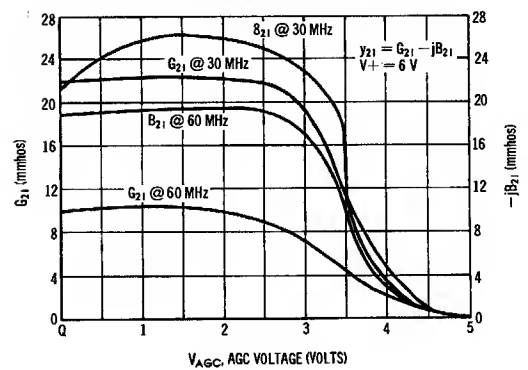


FIGURE 11 — MAXIMUM TRANSDUCER POWER GAIN  
versus FREQUENCY

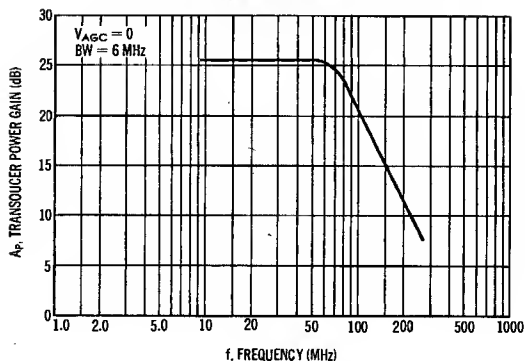


FIGURE 12 — TRANSDUCER POWER GAIN  
versus TEMPERATURE

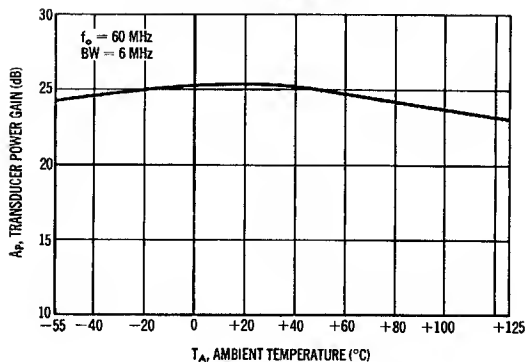


FIGURE 13 — TRANSDUCER POWER BANDWIDTH versus AGC VOLTAGE

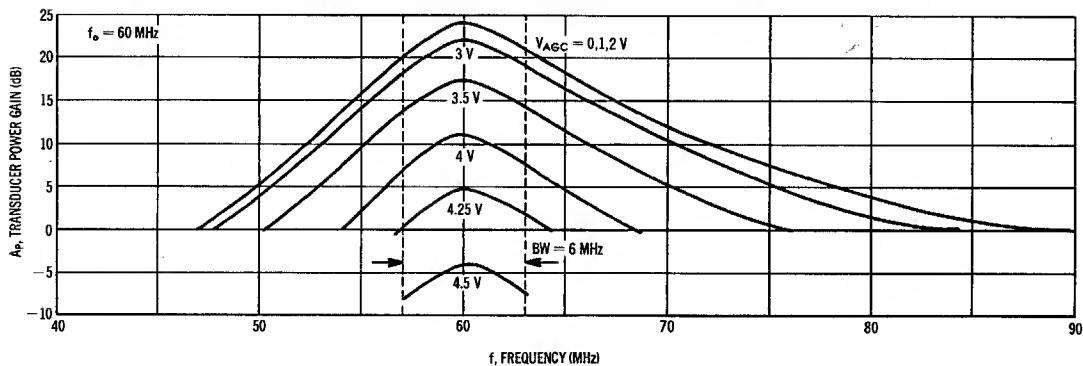


FIGURE 14 — NOISE FIGURE AND OPTIMUM SOURCE RESISTANCE  
versus FREQUENCY

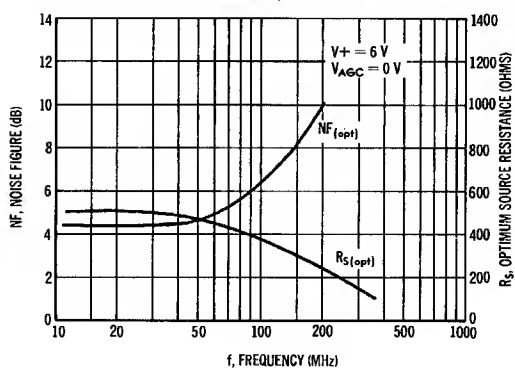
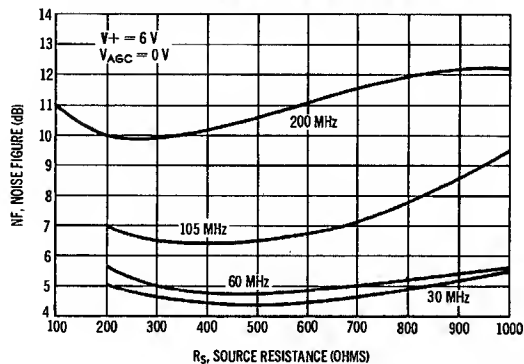


FIGURE 15 — NOISE FIGURE versus SOURCE RESISTANCE



## MC1552G MC1553G

... a three-stage, direct-coupled, common-emitter cascade incorporating series-series feedback to achieve stable voltage gain, low distortion, and wide bandwidth. Employs a temperature-compensated dc feedback loop to stabilize the operating point and a current-biased emitter follower output. Intended for use as either a wide-band linear amplifier or as a fast rise pulse amplifier.

### Typical Amplifier Features:

- High Gain — 34 dB  $\pm 1.0$  dB (MC1552)  
52 dB  $\pm 1.0$  dB (MC1553)
- Wide Bandwidth — 40 MHz (MC1552)  
35 MHz (MC1553)
- Low Distortion — 0.2% at 200 kHz
- Low Temperature Drift —  $\pm 0.002$  dB/ $^{\circ}$ C



Lead 6 connected to case

CASE 71

### MAXIMUM RATINGS ( $T_A = 25^{\circ}$ C unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage, Pin 9	$V^+$	9	Vdc
Input Voltage, Pin 1 to Pin 2 ( $R_S = 500$ ohms)	$V_{in}$	1.0	V(RMS)
Power Dissipation (Package Limitation) Derate above $25^{\circ}$ C	$P_D$	680 4, 6	mW mW/ $^{\circ}$ C
Operating Temperature Range	$T_A$	-55 to +125	$^{\circ}$ C
Storage Temperature Range	$T_{stg}$	-65 to +150	$^{\circ}$ C

### CIRCUIT SCHEMATICS

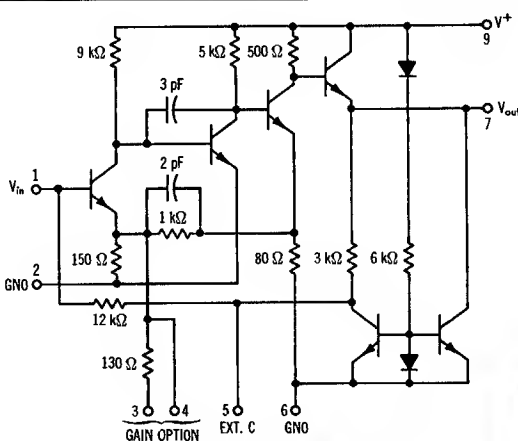


FIGURE 1 — MC1552 (LOW GAIN)

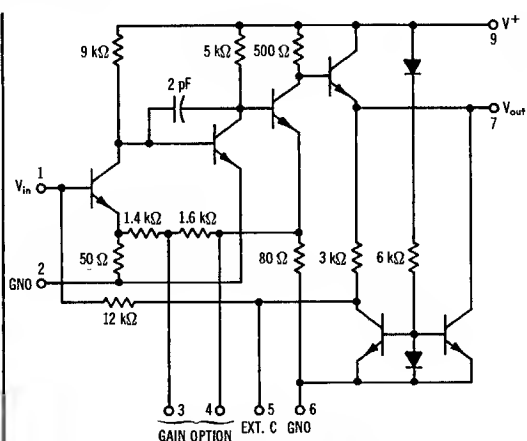


FIGURE 2 — MC1553 (HIGH GAIN)

# MC1552G, MC1553G (continued)

## ELECTRICAL CHARACTERISTICS (V<sup>+</sup> = +6 Vdc, T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic		Fig. No.	Gain * Option	Symbol	Min	Typ	Max	Unit
Voltage Gain	MC1552	3	50 100	$V_{out}/V_{in}$	44 87	50 100	56 113	V/V
	MC1553		200 400		175 350	200 400	225 450	
Voltage Gain Variation ( $T_A = -55^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ )		3	All	—	—	$\pm 0.2$	—	dB
Bandwidth	MC1552	3, 6	50 100	BW	21 17	40 35	—	MHz
	MC1553		200 400		17 7.5	35 15	—	
Input Impedance ( $f = 100\text{ kHz}$ , $R_L = 1\text{ k}\Omega$ )		—	All	$ Z_{in} $	7	10	—	k $\Omega$
Output Impedance ( $f = 100\text{ kHz}$ , $R_S = 50\text{ }\Omega$ )		—	All	$ Z_{out} $	—	16	50	$\Omega$
DC Output Voltage		3	All	$V_{out}(\text{dc})$	2.5	2.9	3.2	Vdc
DC Output Voltage Variation ( $T_A = -55^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ )		3	All	$\Delta V_{out}(\text{dc})$	—	$\pm 0.05$	—	Vdc
Output Voltage Swing ( $Z_L \geq 1\text{ k}\Omega$ , $V_{in} = 100\text{ mV rms}$ )		3	All	$V_{out}$	3.6	4.2	—	V <sub>p-p</sub>
Power Dissipation		—	All	$P_D$	—	75	120	mW
Delay Time	MC1552	3, 4	50 100	$t_{pd}$	— —	8 9	— —	ns
	MC1553		200 400		— —	10 25	— —	
Rise Time	MC1552	3, 4	50 100	$t_r$	— —	9 12	16 20	ns
	MC1553		200 400		— —	11 30	20 45	
Overshoot		3, 4	All	$(V_{os}/V_p)100$	—	5	—	%
Noise Figure ( $R_S = 400\text{ }\Omega$ , $f_o = 30\text{ MHz}$ , BW = 3 MHz)		—	All	NF	—	5	—	dB
Total Harmonic Distortion ( $V_{out} = 2\text{ V}_{p-p}$ , $f = 200\text{ kHz}$ , $R_L = 1\text{ k}\Omega$ )		—	All	THD	—	0.2	—	%

\* To obtain the voltage-gain characteristic desired, use the following pin connections:

Type	Voltage Gain	Pin Connections
MC1552	50	Pin 3 Open
	100	Ground Pin 3
MC1553	200	Connect Pin 3 to Pin 4
	400	Pins 3 and 4 Open

## NOTES

1. Ground Pin 6 as close to can as possible to minimize overshoot. Best results by directly grounding can.

2. If large input and output coupling capacitors are used, place shield between them to avoid input-output coupling.

3. A high-frequency capacitor must always be used to bypass the power supply. This capacitor should be as close to the circuit as possible.

4. Voltage gain can be adjusted to any value between 50 and 3000 by connecting an external resistor from Pin 4 to ground on MC1552, or from Pin 3 to ground on MC1553, as shown in

Figure 8. Under these conditions, the following equations must be used to determine C<sub>1</sub> and C<sub>2</sub> rather than the circuits shown in Figure 5.

$$\text{Fig. 5b } C_1 = \frac{1}{2\pi f_c (1.7 \times 10^4)} \text{ Farads; } C_2 = \frac{1}{8 C_1 (V_{out}/V_{in})} \text{ Farads}$$

$$\text{Fig. 5c } C_1 = \frac{V_{out}/V_{in}}{2\pi f_c (1.5 \times 10^4)} \text{ Farads}$$

$$\text{Fig. 5d } C_2 = \frac{V_{out}/V_{in}}{2\pi f_c (3 \times 10^3)} \text{ Farads}$$

FIGURE 3—TEST CIRCUIT

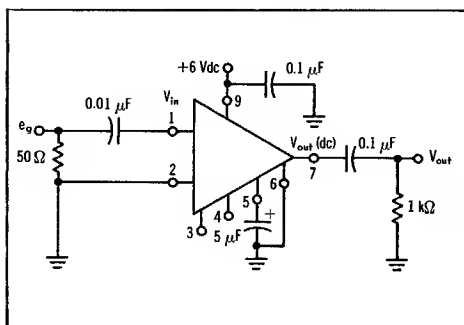
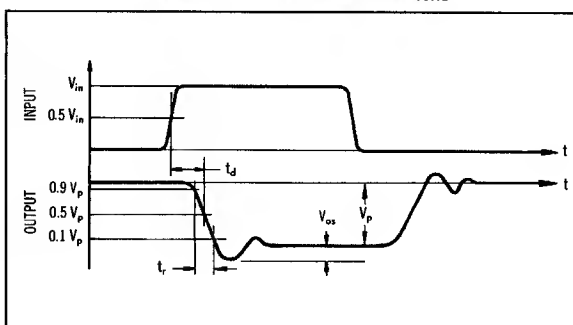


FIGURE 4—PULSE RESPONSE DEFINITIONS

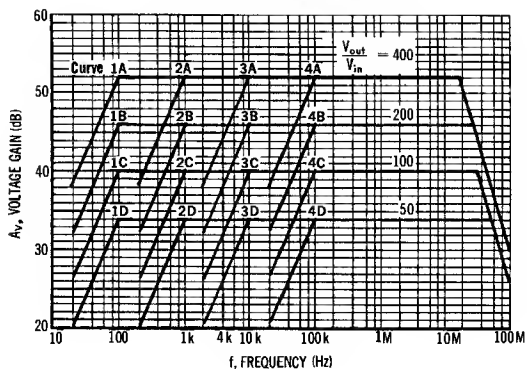




## TYPICAL CHARACTERISTICS

 $T_A = 25^\circ\text{C}$ 

FIGURE 5a—FREQUENCY RESPONSE



## TEST CIRCUITS FOR FREQUENCY RESPONSE

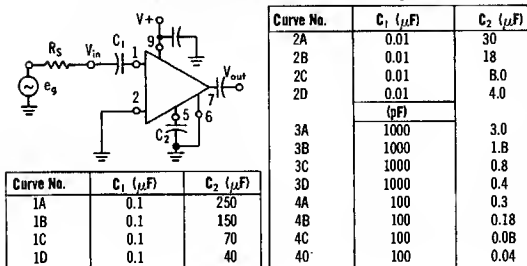
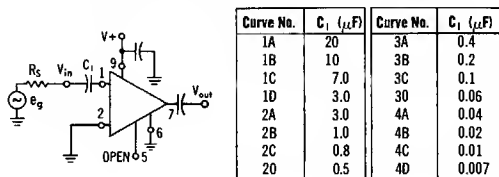
FIGURE 5b—CAPACITIVE COUPLED INPUT ( $R_s < 5k\Omega$ )FIGURE 5c—CAPACITIVE COUPLED INPUT ( $R_s < 500\Omega$ )

FIGURE 5d—TRANSFORMER COUPLED INPUT

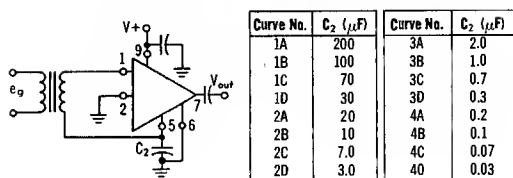


FIGURE 6—VOLTAGE GAIN versus FREQUENCY

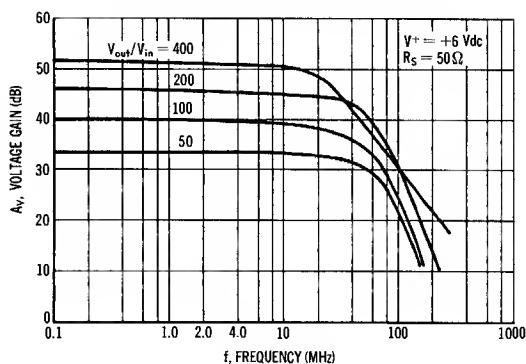


FIGURE 7—MAXIMUM NEGATIVE SWING SLEW RATE versus LOAD CAPACITANCE

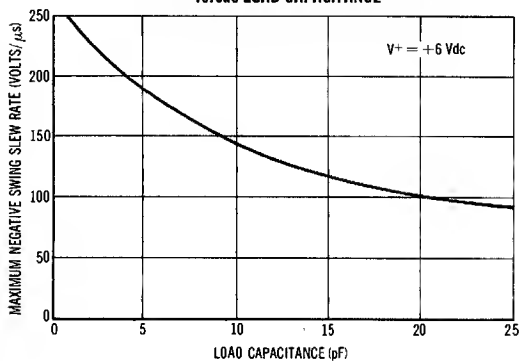
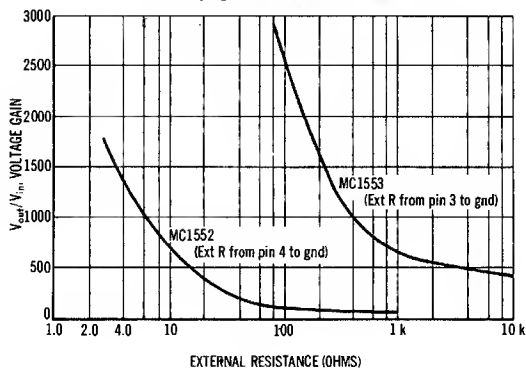


FIGURE 8—VOLTAGE GAIN ADJUSTMENT BY USE OF EXTERNAL RESISTOR



# INPUT ADMITTANCE

$V^+ = 6 \text{ Vdc}$ ,  $R_L = 1 \text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$

FIGURE 9 — GAIN = 50

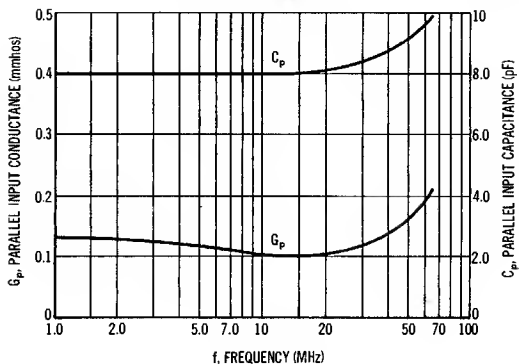


FIGURE 10 — GAIN = 100

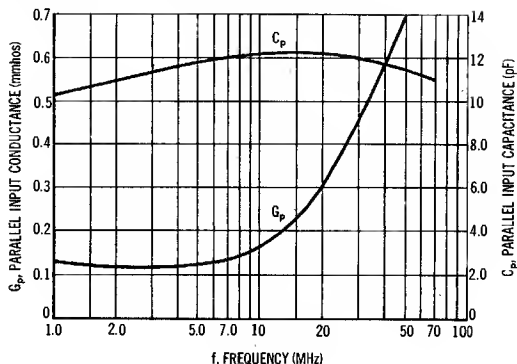


FIGURE 11 — GAIN = 200

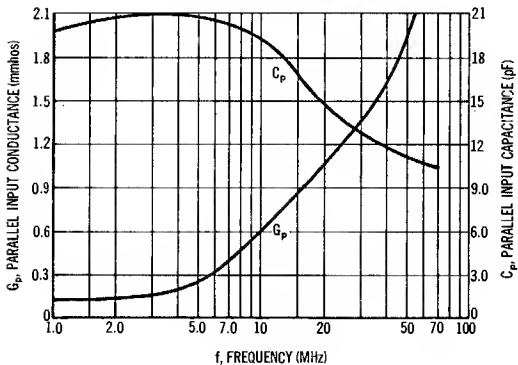


FIGURE 12 — GAIN = 400

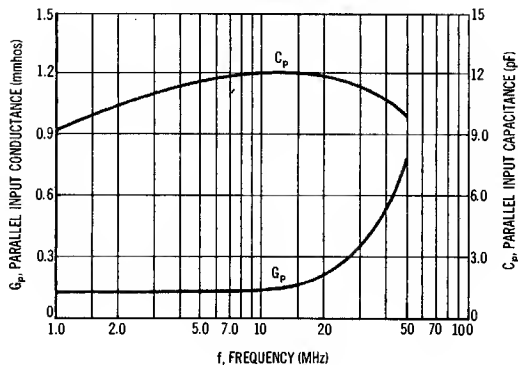


FIGURE 13 — OUTPUT IMPEDANCE versus FREQUENCY

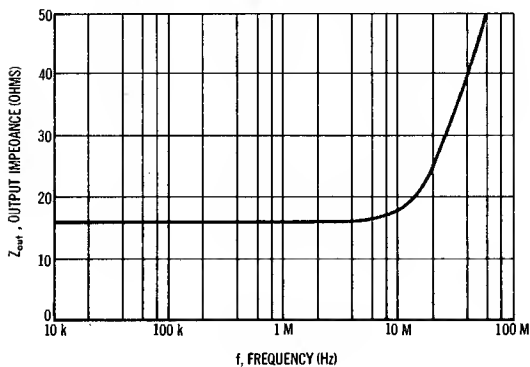
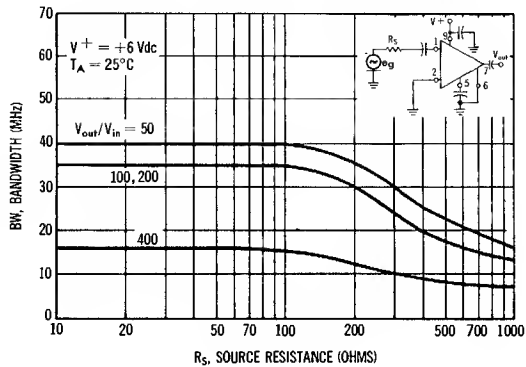


FIGURE 14 — BANDWIDTH versus SOURCE RESISTANCE



**MC1524****Typical Amplifier Features:**

- Low Standby Current Drain –  $< 4 \text{ mA}$
- Low Total Harmonic Distortion
- 1-Watt Power Output
- Low Output Impedance
- Direct Coupling to Load
- Excellent Gain – Temperature Stability

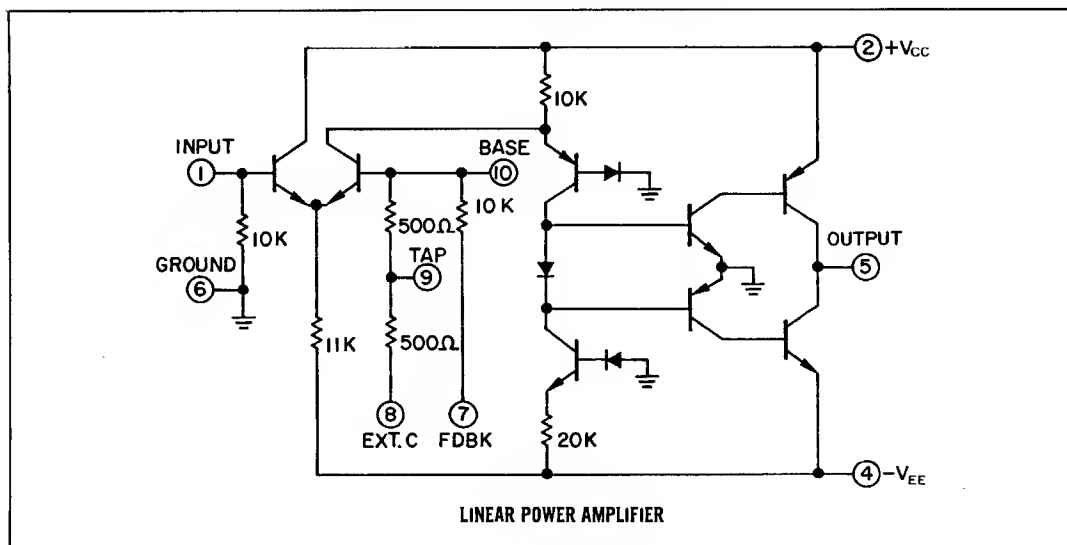


CASE 71

Lead 6 connected to case

**ABSOLUTE MAXIMUM RATINGS** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V_{CC}$	12	Vdc
Power Supply Voltage	$V_{EE}$	-12	Vdc
Operating Temperature Range	$T_A$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +175	$^\circ\text{C}$
Maximum Audio Output Power ( $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ )	$P_{out(max)}$	1.0	Watt

**FIGURE 1 – CIRCUIT SCHEMATIC**

# MC1524 (continued)

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = +6V$ , $V_{EE} = -6V$ , $T_A = 25^\circ C$ . See Fig. 1)

Characteristic	Load Impedance ohms	Feedback Tap ohms	Symbol	Min	Typ	Max	Units
Maximum Peak-to-Peak Output Voltage for THD $< 3\%$ @ 1 kHz	16	1000	$V_{Omax}$	9.0	10.0	—	$V_{(P-P)}$
Voltage Gain @ 1 kHz	16	250	$A_v$	—	37.9	—	—
		500		—	20.0	—	
		1000		10.0	11.5	12.5	
	100	250		—	41.2	—	
		500		—	21.3	—	
		1000		11.0	12.3	13.5	
Input Impedance @ 1 kHz	—	1000	$Z_{in}$	6.0	8.5	—	kohms
Output Impedance @ 1 kHz	—	1000	$Z_{out}$	—	0.58	0.80	ohms
Bandwidth	16	250	BW	—	350	—	kHz
		500		—	480	—	
		1000		250	770	—	
	40	250		—	840	—	
		500		—	460	—	
		1000		—	790	—	
	100	250		—	320	—	
		500		—	480	—	
		1000		—	810	—	
Zero Signal Current Drain (Each Supply)	16	1000	$I_S$	—	1.5	4.0	mA
Low Level Total Harmonic Distortion @ 1 kHz (50 mVrms in)	16	1000	THD	—	0.6	2.0	%

FIGURE 1 — AC COUPLED CIRCUIT

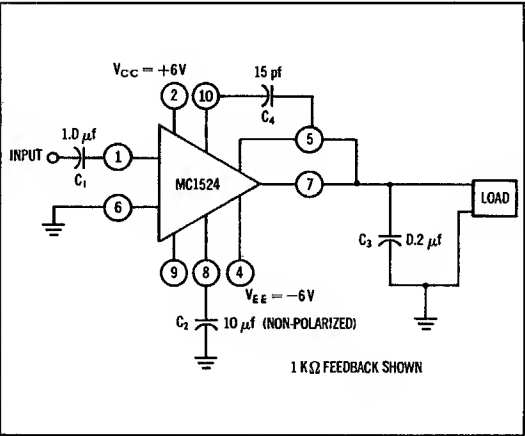
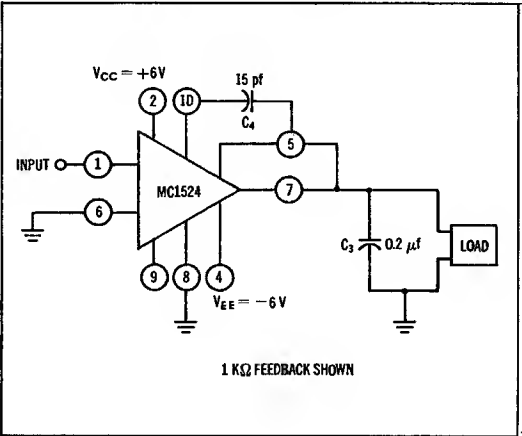


FIGURE 2 — DC COUPLED CIRCUIT

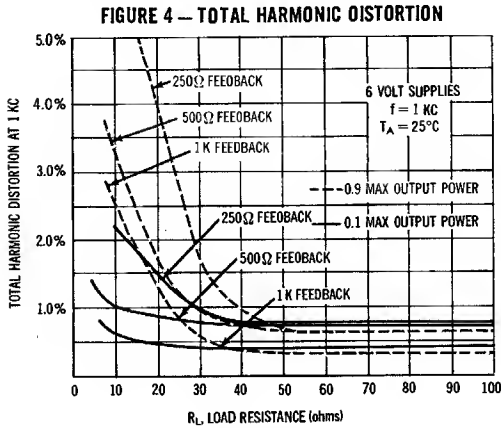


### RECOMMENDED OPERATING CONDITIONS

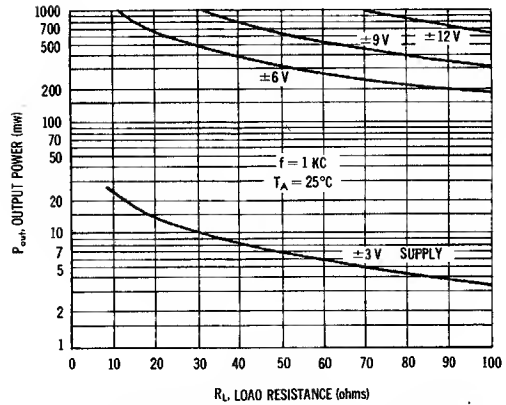
- 1) DC load resistance ( $R_L$ ) should be greater than 5 ohms for DC stability.
- 2) Power supplies should be balanced, have low source impedances, and should be turned on and off simultaneously. (See Fig. 6 for Standby Current vs. Supply Unbalance.)
- 3) Capacitors  $C_3$  and  $C_4$  provide high-frequency stability. For most loads, at temperatures below 70°C,  $C_4$  may be omitted.
- 4) Low frequency rolloff of AC coupled circuit is determined by  $C_1$  and  $C_2$ . Fig 1 is recommended for loudspeaker loads because of DC stability introduced by  $C_2$ .
- 5) Open loop operation is not recommended. Feedback taps are connected as follows:

Feedback Tap Pin Connection

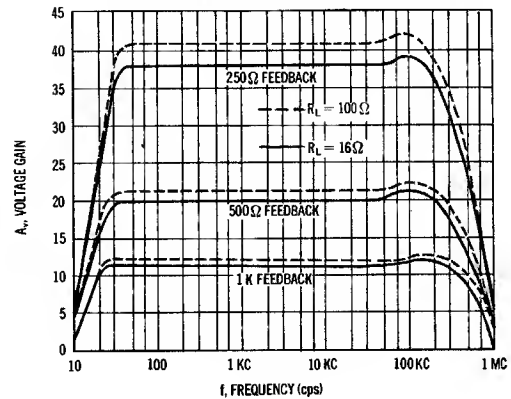
1 K $\Omega$	8 to $C_2$ (AC) or ground (DC)
500 $\Omega$	9 to $C_2$ (AC) or ground (DC)
250 $\Omega$	8 to 10; 9 to $C_2$ (AC) or ground (DC)



**FIGURE 3 — MAXIMUM AVAILABLE OUTPUT POWER**  
(BEFORE CLIPPING — RESISTIVE LOAD)



**FIGURE 5 — AC COUPLED FREQUENCY RESPONSE**



**FIGURE 6 — STANDBY CURRENT VARIATION DUE TO SUPPLY UNBALANCE**

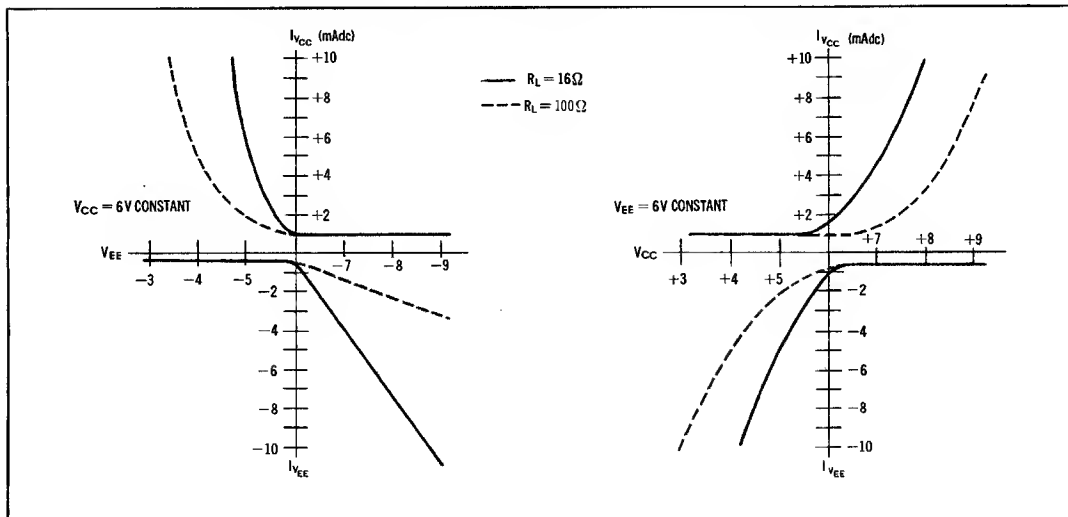


FIGURE 7 — DC TRANSFER CHARACTERISTICS

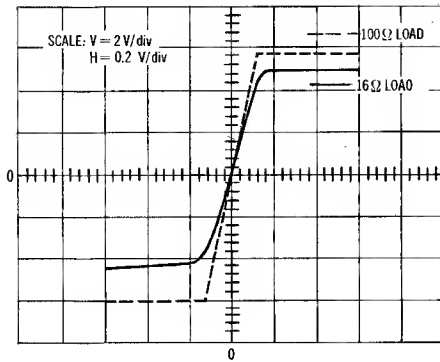
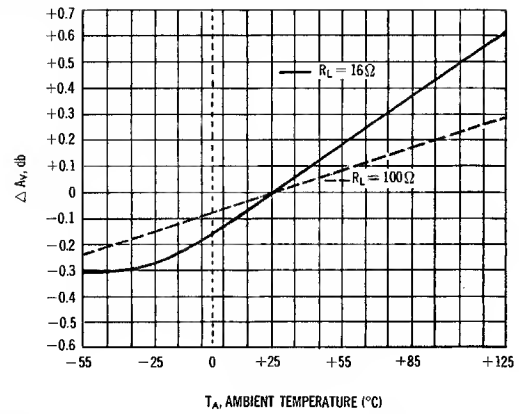
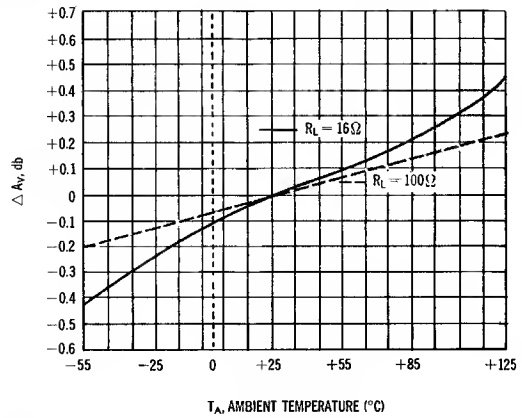
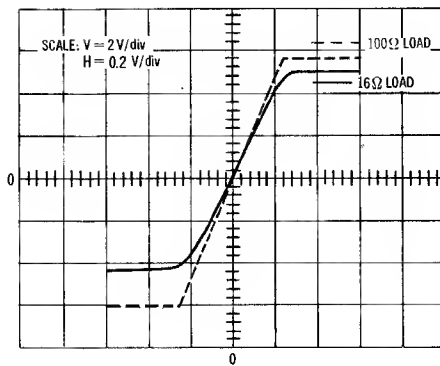


FIGURE 8 — VOLTAGE GAIN versus TEMPERATURE

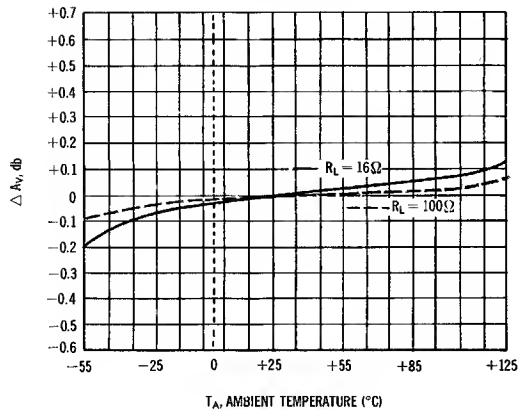
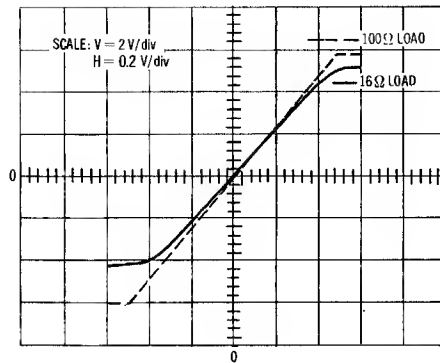
250 $\Omega$  FEEDBACK TAP



500 $\Omega$  FEEDBACK TAP



1 K $\Omega$  FEEDBACK TAP



**MC1554G**

... designed to amplify signals to 300 kHz with one watt delivered to a direct or capacitively coupled load.

**Typical Amplifier Features:**

- Low Total Harmonic Distortion — 0.4% typical at 1.0 Watt
- Low Output Impedance — 0.2 ohm
- Excellent Gain — Temperature Stability

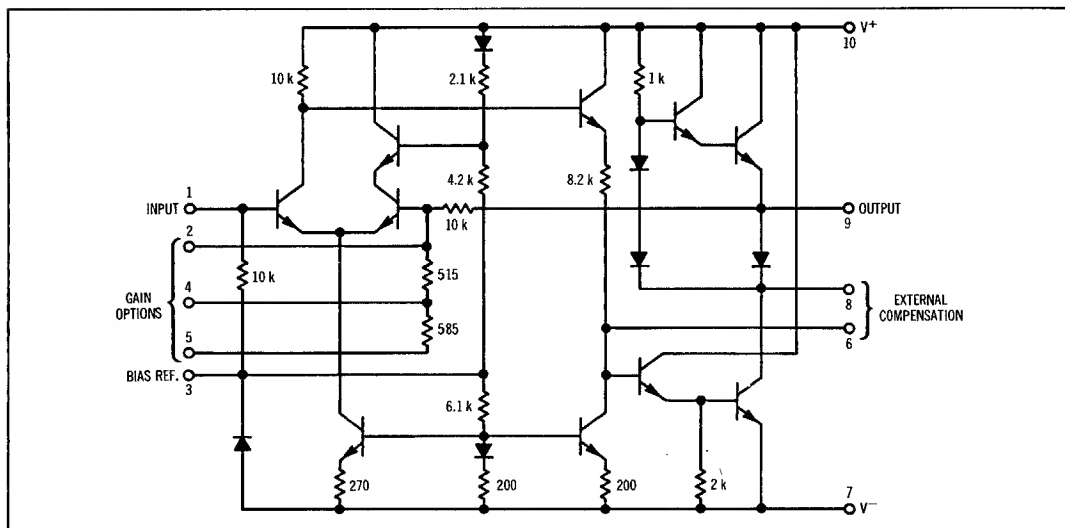


CASE 71

Lead 7 connected to case

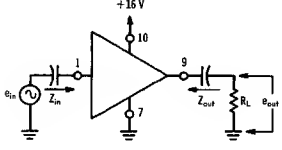
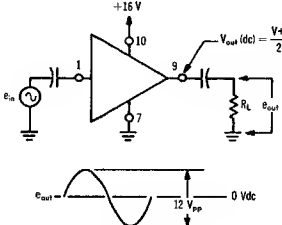
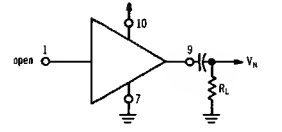
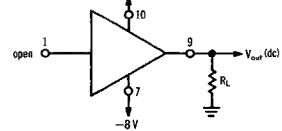
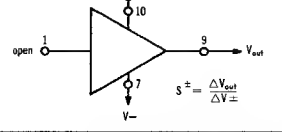
**MAXIMUM RATINGS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Rating	Symbol	Value	Unit
Total Power Supply Voltage	$ V^+  +  V^- $	18	Vdc
Peak Load Current	$I_{\text{out}}$	0.5	Amp
Audio Output Power	$P_{\text{out}}$	1.8	Watt
Power Dissipation (package limitation) $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	600 4.8	mW mW/ $^\circ\text{C}$
$T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$		1.8 14.4	Watts mW/ $^\circ\text{C}$
Operating Temperature Range	$T_C$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{\text{stg}}$	-55 to +150	$^\circ\text{C}$

**CIRCUIT SCHEMATIC**

MC1554G (continued)

ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25 °C unless otherwise noted)  
Frequency compensation shown in Figures 2 and 3.

Characteristic Definitions	Characteristic	R <sub>L</sub> (ohms)	Gain Option*	Symbol	Min	Typ	Max	Unit
	Output Power	16	-	P <sub>out</sub>	1.0	1.1	-	Watt
	Power Dissipation (@ P <sub>out</sub> = 1.0 W)	16	-	P <sub>D</sub>	-	0.9	1.2	Watt
	Voltage Gain	16 18 36	10 18 36	A <sub>V</sub>	8.0 - -	10 18 36	-	V/V
	Input Impedance	-	10	Z <sub>in</sub>	7.0	10	-	kΩ
	Output Impedance	-	10	Z <sub>out</sub>	-	0.2	-	Ω
	Power Bandwidth (for e <sub>out</sub> < 5% THD)	16 18 36	10 18 36		- - -	270 250 210	-	kHz
	Total Harmonic Distortion (for e <sub>in</sub> < 0.05% THD, f = 20 Hz to 20 kHz)			THD				%
	P <sub>out</sub> = 1.0 Watt (sinewave) P <sub>out</sub> = 0.1 Watt (sinewave)	16 16	10 10		- -	0.4 0.5	-	
	Zero Signal Current Drain	∞	-	I <sub>D</sub>	-	11	15	mAdc
	Output Noise Voltage	16	10	V <sub>n</sub>	-	0.3	-	mV RMS
	Output Quiescent Voltage (Split Supply Operation)	16	-	V <sub>out</sub> (dc)	-	±10	±30	mVdc
	Positive Supply Sensitivity (V <sup>+</sup> constant)	∞	-	S <sup>+</sup>	-	-40	-	mV/V
	Negative Supply Sensitivity (V <sup>-</sup> constant)	∞	-	S <sup>-</sup>	-	-40	-	mV/V

\* To obtain the voltage gain characteristic desired, use the following pin connections:

Voltage Gain	Pin Connection
10	Pins 2 and 4 open, Pin 5 to ac ground
18	Pins 2 and 5 open, Pin 4 to ac ground
36	Pin 2 connected to Pin 5, Pin 4 to ac ground

TYPICAL CONNECTIONS

FIGURE 2—SPLIT SUPPLY OPERATION  
VOLTAGE GAIN (A<sub>V</sub>) = 10, f<sub>LOW</sub> ≈ 25 Hz

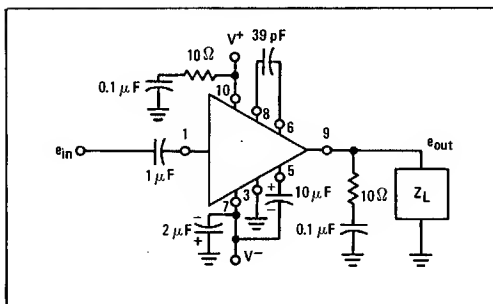
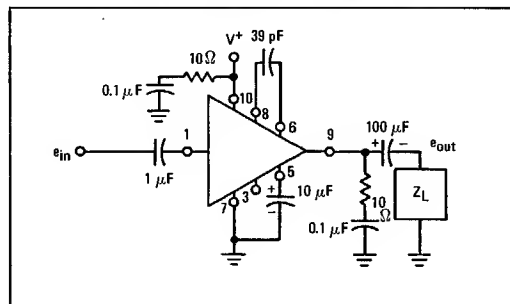


FIGURE 3—SINGLE SUPPLY OPERATION  
VOLTAGE GAIN (A<sub>V</sub>) = 10, f<sub>LOW</sub> ≈ 100 Hz





## RECOMMENDED OPERATING CONDITIONS

In order to avoid local VHF instability, the following set of rules must be adhered to:

1. An R-C stabilizing network ( $0.1 \mu\text{F}$  in series with 10 ohms) should be placed directly from pin 9 to ground, as shown in Figures 2 and 3, using short leads, to eliminate local VHF instability caused by lead inductance to the load.
2. Excessive lead inductance from the  $V+$  supply to pin 10 can cause high frequency instability. To prevent this, the  $V+$  by-pass capacitor should be connected with short leads from the  $V+$  pin to ground. If this capacitor is remotely located a series R-C network ( $0.1 \mu\text{F}$  and 10 ohms) should be used directly from pin 10 to ground as shown in Figures 2 and 3.
3. Lead lengths from the external components to pins 7, 9, and 10 of the package should be as short as possible to insure good VHF grounding for these points.

Due to the large bandwidth of the amplifier, coupling must be avoided between the output and input leads. This can be assured by either (a) use of short leads which are well isolated, (b) narrow-banding the overall amplifier by placing a capacitor from pin 1 to ground to form a low-pass filter in combination with the source impedance, or (c) use of a shielded input cable. In applications which require upper band-edge control the input low-pass filter is recommended.

## TYPICAL CHARACTERISTICS

FIGURE 4—MAXIMUM AVAILABLE OUTPUT POWER (SINE WAVE)

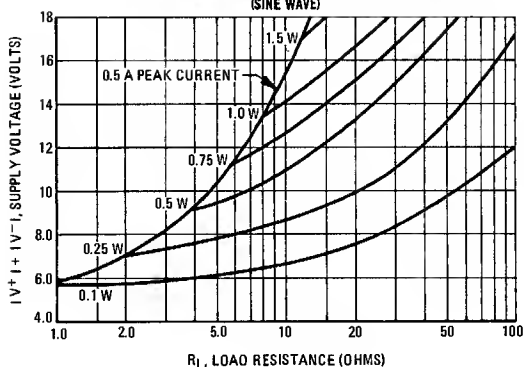


FIGURE 5—MAXIMUM DEVICE DISSIPATION (SINE WAVE)

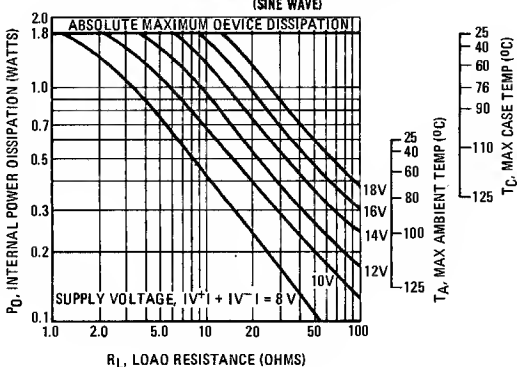


FIGURE 6—TOTAL HARMONIC DISTORTION versus LOAD RESISTANCE

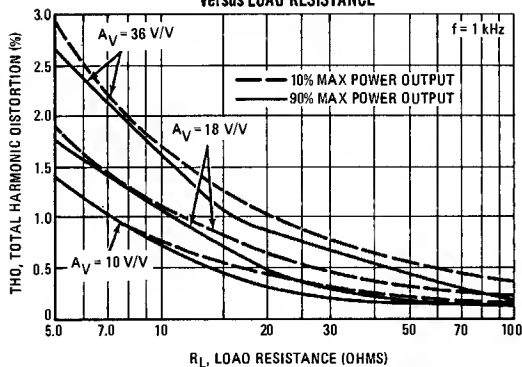
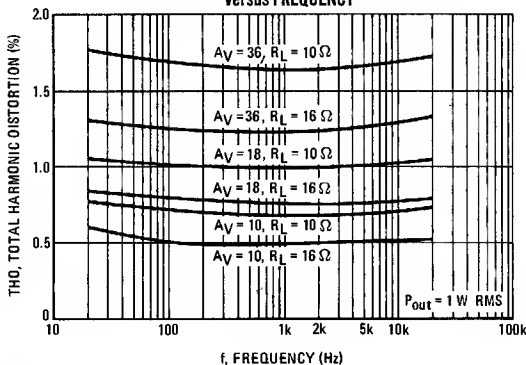


FIGURE 7—TOTAL HARMONIC DISTORTION versus FREQUENCY



## TYPICAL CHARACTERISTICS

FIGURE 8—VOLTAGE GAIN versus TEMPERATURE

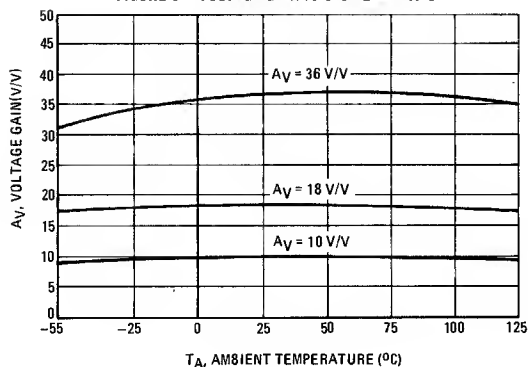
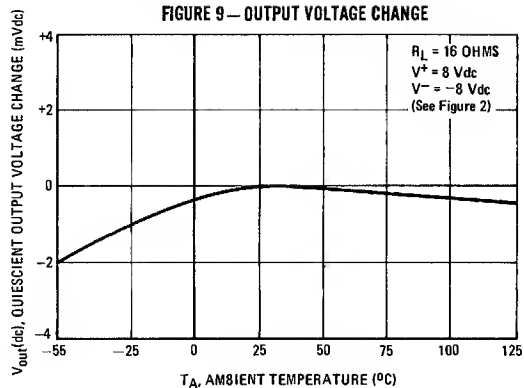
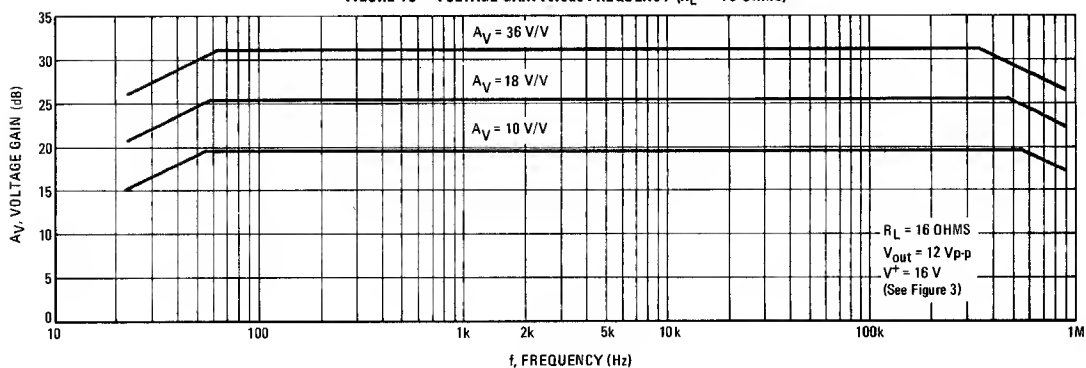
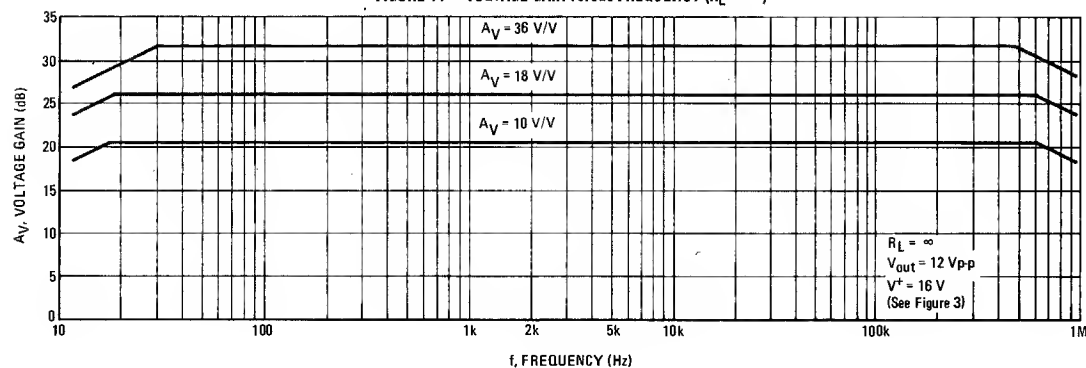


FIGURE 9—OUTPUT VOLTAGE CHANGE

FIGURE 10—VOLTAGE GAIN versus FREQUENCY ( $R_L = 16 \text{ OHMS}$ )FIGURE 11—VOLTAGE GAIN versus FREQUENCY ( $R_L = \infty$ )

# DIFFERENTIAL AMPLIFIER

# DIFFERENTIAL AMPLIFIERS

## MC1519

... featuring NPN inputs and PNP outputs. Two monolithic compatible\* chips are used to provide a versatile and extremely stable amplifier.

\*Compatible — a process utilizing thin film resistors deposited on a silicon monolithic integrated circuit.



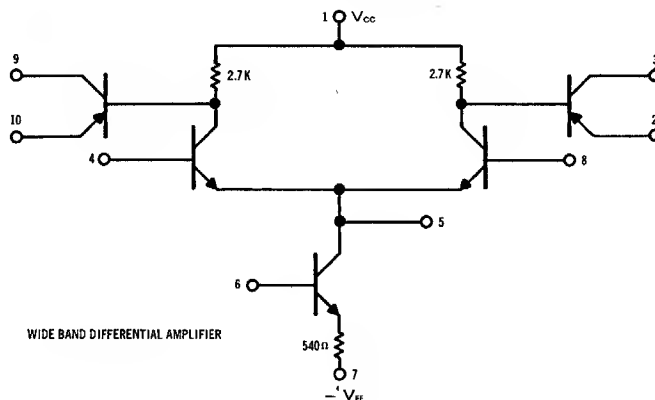
CASE 71

All pins electrically isolated from package

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V_{CC}$	+14	Vdc
Power Supply Voltage	$V_{EE}$	-14	Vdc
Differential Input Signal	$V_{in}$	$\pm 5$	Vdc
Total Power Dissipation Derate above $25^\circ\text{C}$	$P_D$	300 2.0	mW mW/ $^\circ\text{C}$
Operating Temperature Range	$T_J$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +175	$^\circ\text{C}$

### CIRCUIT SCHEMATIC

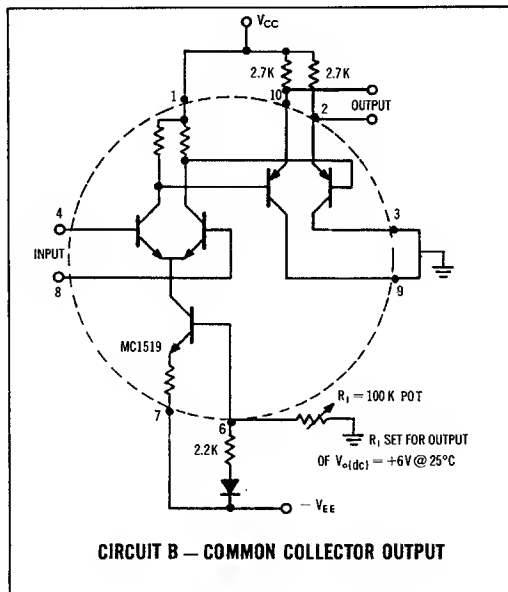
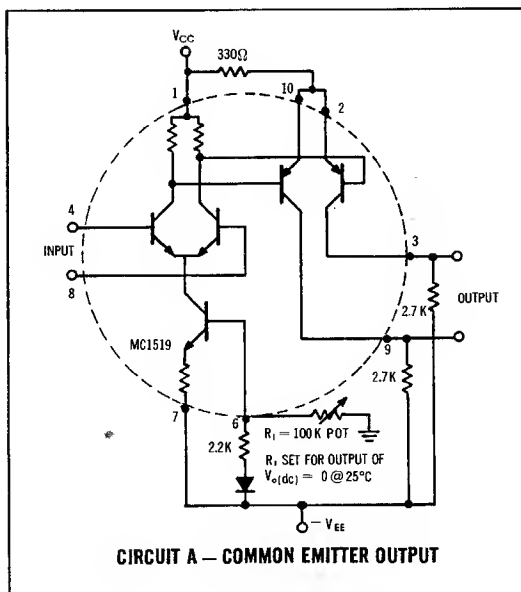


# MC1519 (continued)

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = +12\text{ Vdc}$ , $V_{EE} = -12\text{ Vdc}$ , $T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Figure No.	Symbol	Min	Typ	Max	Unit
Differential Voltage Gain Circuit A (CE) Circuit B (CC)	3, 8	$A_{dd}$	87 40	73 45	79 50	db
Single Ended Voltage Gain Circuit A (CE) Circuit B (CC)	3	$A_V$	— —	67 38	— —	db
Maximum Output Swing Circuit A (CE) Circuit B (CC)	4	$V_O$	12.0 8.0	14.0 10.0	— —	$V_{(p-p)}$
Input Offset Voltage Circuit A (CE) Circuit B (CC)	5, 9	$V_{IO}$	— —	2.0 2.0	6.0 6.0	mVdc
Input Offset Voltage Drift Circuit A (CE) Circuit B (CC)	5, 9	$V_{IOD}$	— —	5.0 5.0	— —	$\mu\text{V}/^\circ\text{C}$
Input Offset Current Circuit A (CE) Circuit B (CC)	6, 10	$I_{IO}$	— —	1.0 2.0	4.0 8.0	$\mu\text{Adc}$
Input Current Circuit A (CE) Circuit B (CC)	6, 11	$I_i$	— —	40.0 60.0	70.0 90.0	$\mu\text{Adc}$
Common Mode Rejection Circuit A (CE) Circuit B (CC)	7	$CM_{Rej}$	— —	89.0 86.0	— —	db
Bandwidth - 3 db Circuit A (CE) Circuit B (CC)	3, 12	BW	0.70 5.0	1.0 8.0	— —	mc
Differential Input Impedance Circuit A (CE) Circuit B (CC)	2	$Z_{in}$	1.8 —	2.6 1.2	— —	kohms
Single Ended Output Impedance Circuit A (CE) Circuit B (CC)	2	$Z_{out}$	— —	2.7 0.048	— 0.120	kohms

FIGURE 1



## TEST CIRCUITS

FIGURE 2 — DIFFERENTIAL INPUT IMPEDANCE AND SINGLE-ENDED OUTPUT IMPEDANCE

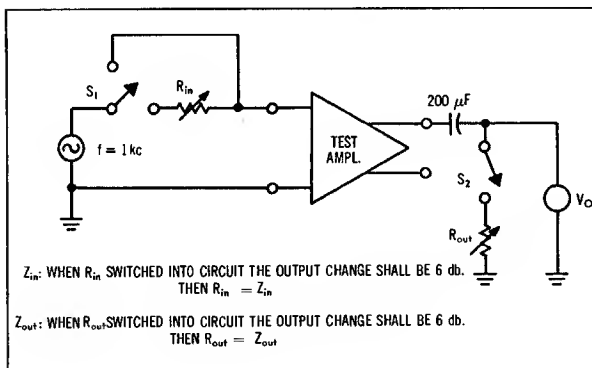


FIGURE 3 — DIFFERENTIAL VOLTAGE GAIN, SINGLE-ENDED VOLTAGE GAIN, and BANDWIDTH

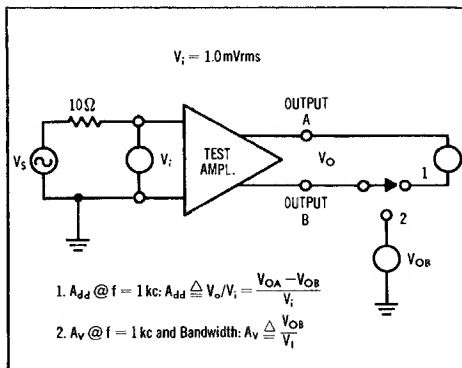


FIGURE 4 — MAXIMUM OUTPUT SWING

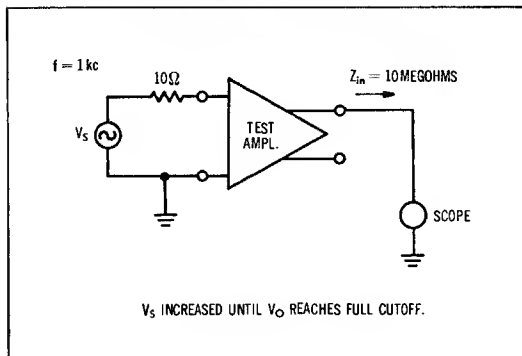


FIGURE 5 — INPUT OFFSET VOLTAGE

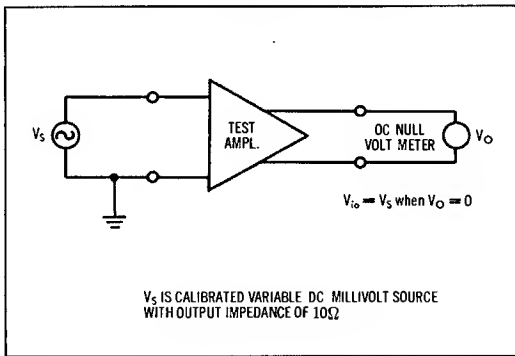


FIGURE 6 — INPUT OFFSET CURRENT and INPUT CURRENT

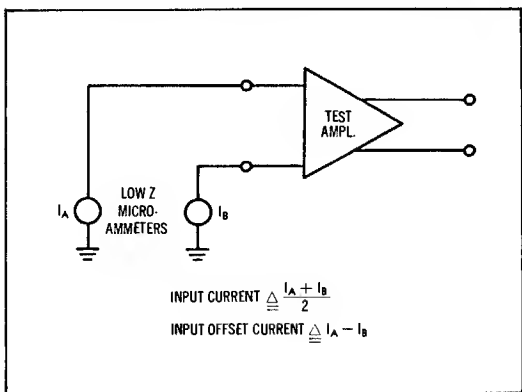
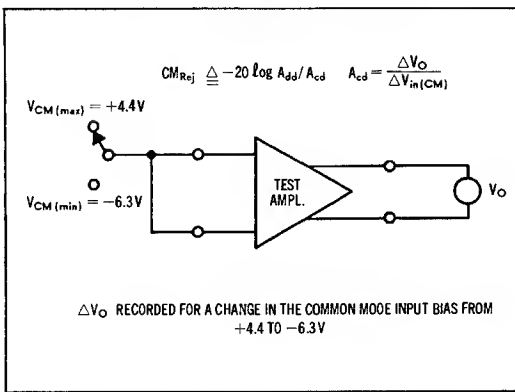


FIGURE 7 — COMMON MODE REJECTION



EFFECT OF TEMPERATURE ON CIRCUIT B CHARACTERISTICS

$R_1$  SET FOR  $V_{O(CM)} = +6V$  AT  $+25^\circ C$

FIGURE 8 — DIFFERENTIAL MODE GAIN

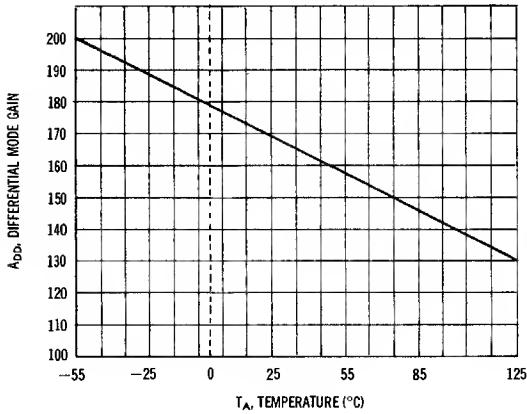


FIGURE 9 — INPUT OFFSET VOLTAGE

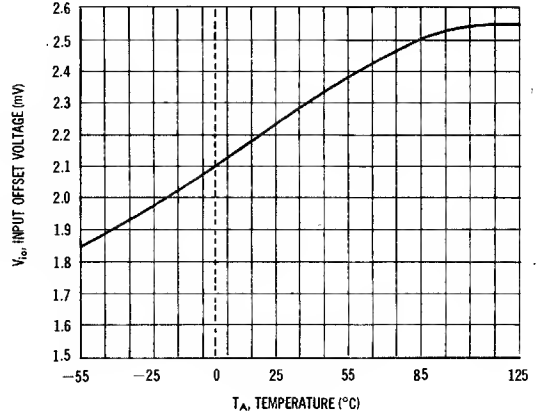


FIGURE 10 — INPUT OFFSET CURRENT

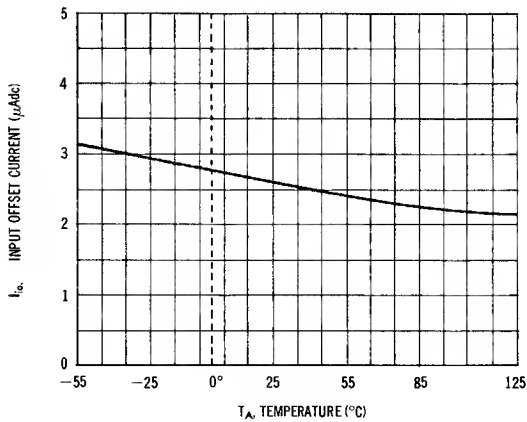


FIGURE 11 — INPUT CURRENT

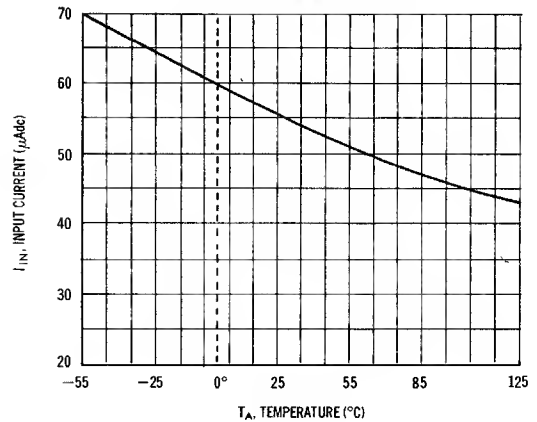


FIGURE 12 — CIRCUIT A BANDWIDTH

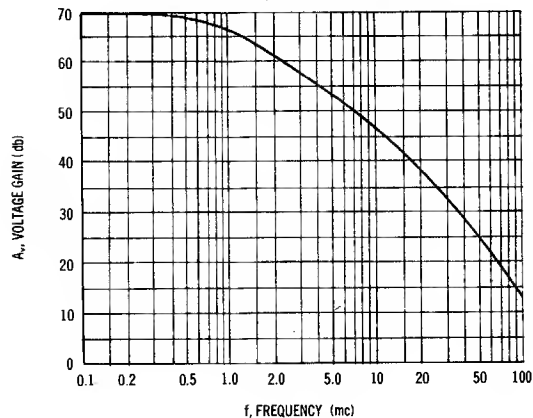
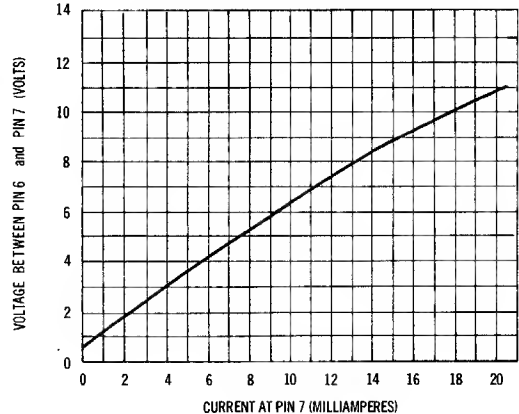


FIGURE 13 — CURRENT SOURCE BIASING



# DIFFERENTIAL AMPLIFIER

# DIFFERENTIAL AMPLIFIERS

## MC1525G MC1526G

... designed for high gain applications. Features built-in temperature compensated current source for excellent temperature stability.

### MONOLITHIC

MC1525G      DIFFERENTIAL AMPLIFIER  
MC1526G      DARLINGTON INPUT  
                    DIFFERENTIAL AMPLIFIER



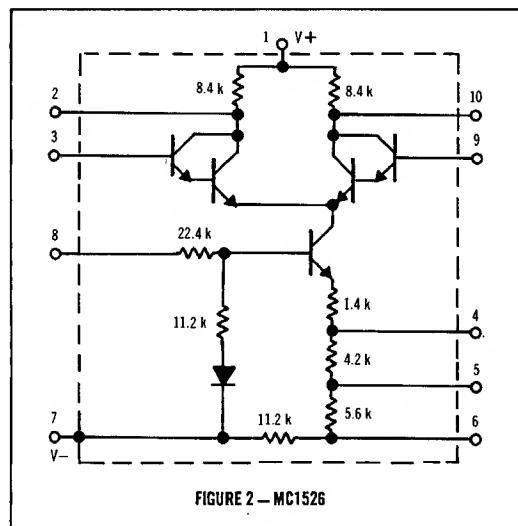
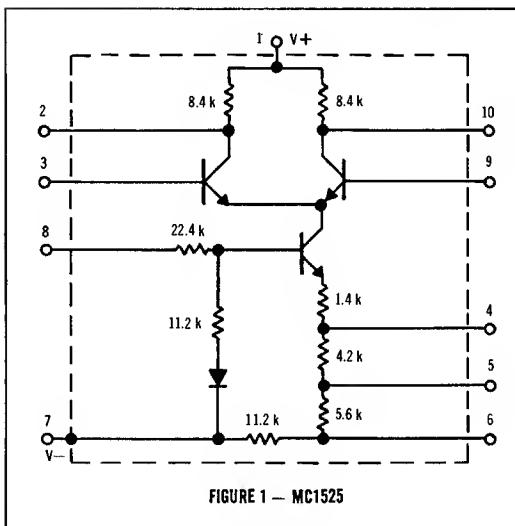
CASE 71

Lead 7 connected to case

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V_+$	+14	Vdc
Power Supply Voltage	$V_-$	-14	Vdc
Differential Input Signal	$V_{in}$	$\pm 5$	Vdc
Operating Temperature Range	$T_A$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +175	$^\circ\text{C}$
Total Power Dissipation, (Package Limitation) Derate above $T_A = 25^\circ\text{C}$	$P_D$	680 4.6	mW mW/ $^\circ\text{C}$

### CIRCUIT SCHEMATICS



# MC1525G, MC1526G (continued)

## ELECTRICAL CHARACTERISTICS (V+ = +12 Vdc, V- = -12 Vdc, at TA = 25°C unless otherwise noted)

Characteristic	Fig No	Symbol	Min	Typ	Max	Unit
Differential Voltage Gain MC1525 MC1526	3, 13	$A_{dd}$	120 50	140 65	160 75	—
Single Ended Voltage Gain MC1525 MC1526	4	$A_v$	— —	75 45	— —	—
Output Voltage, Common Mode Both Types	5, 14	$V_{o(CM)}$	6.0	7.0	8.0	Vdc
Maximum Output Swing Both Types	6	$V_{out}$	7.0	—	—	$V_{(p-p)}$
AC Unbalance Both Types	6	U	—	—	300	mV <sub>(p-p)</sub>
Input Offset Voltage MC1525 MC1526	7, 15	$V_{io}$	— —	— —	5 7	mVdc
Input Offset Current MC1525 MC1526	8, 16	$I_{io}$	— —	— —	4 2	$\mu$ A <sub>dc</sub>
Input Current MC1525 MC1526	8, 18	$I_{in}$	— —	— —	20 3.5	$\mu$ A <sub>dc</sub>
Common Mode Rejection Both Types	9, 17	$CM_{Rej}$	80	—	—	dB
Bandwidth MC1525 MC1526	10	BW	1400 500	— —	— —	kHz
Differential Input Impedance MC1525 MC1526	11	$Z_{in}$	2.0 60	— —	— —	k $\Omega$
Single Ended Output Impedance Both Types	12	$Z_{out}$	—	—	11	k $\Omega$



## MC1525G, MC1526G (continued)

DC Common Mode Input Voltage Set at:  $V_{CM(min)} = 5.5$  Vdc for MC1526G,  $V_{CM(min)} = 6.2$  Vdc for MC1525G

FIGURE 3 — DIFFERENTIAL VOLTAGE GAIN

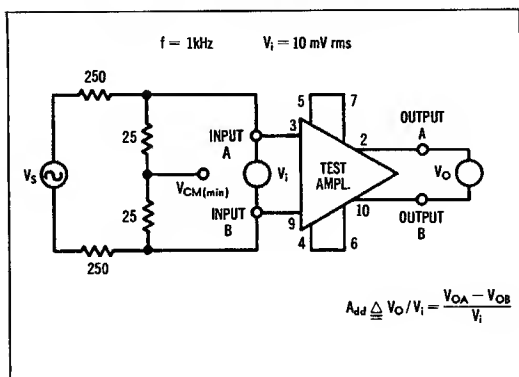


FIGURE 4 — SINGLE-ENDED VOLTAGE GAIN

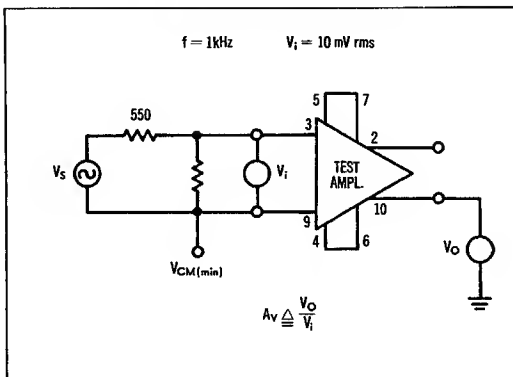


FIGURE 5 — OUTPUT VOLTAGE - COMMON MODE

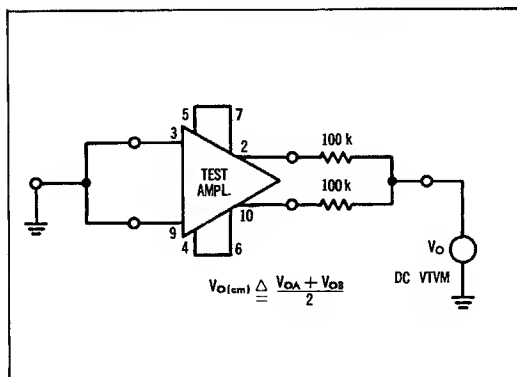


FIGURE 6 — MAXIMUM OUTPUT SWING

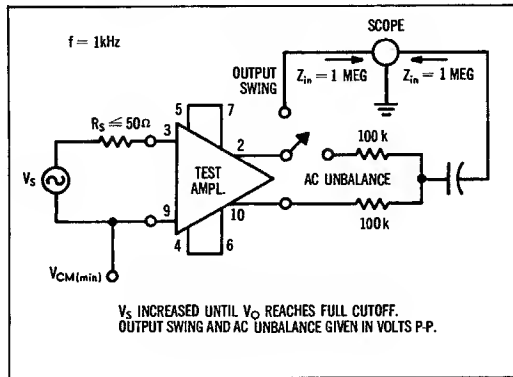


FIGURE 7 — INPUT OFFSET VOLTAGE

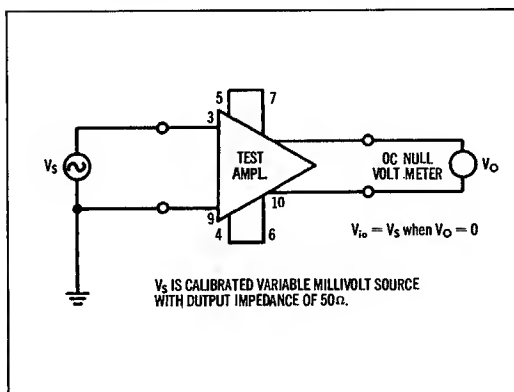
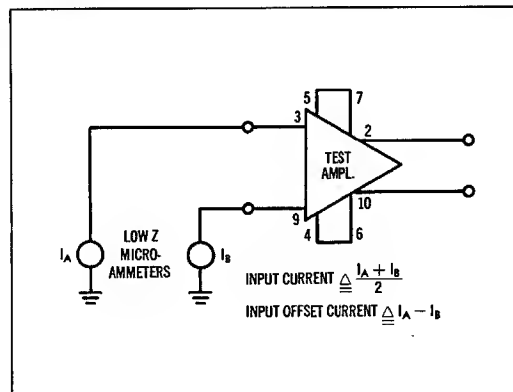


FIGURE 8 — INPUT OFFSET CURRENT and INPUT CURRENT



## MC1525G, MC1526G (continued)

DC Common Mode Input Voltage Set at:  $V_{CM(min)} = 5.5 \text{ Vdc}$  for MC1526G,  $V_{CM(min)} = 6.2 \text{ Vdc}$  for MC1525G

FIGURE 9 — COMMON MODE REJECTION

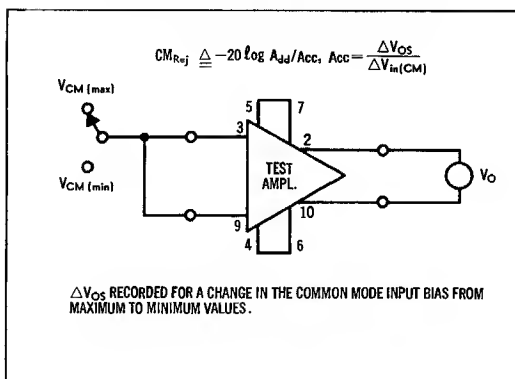


FIGURE 10 — BANDWIDTH

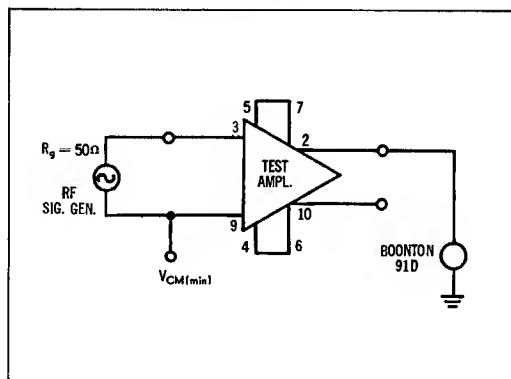


FIGURE 11 — DIFFERENTIAL INPUT IMPEDANCE

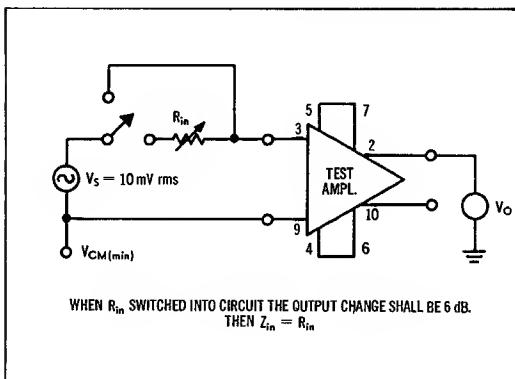
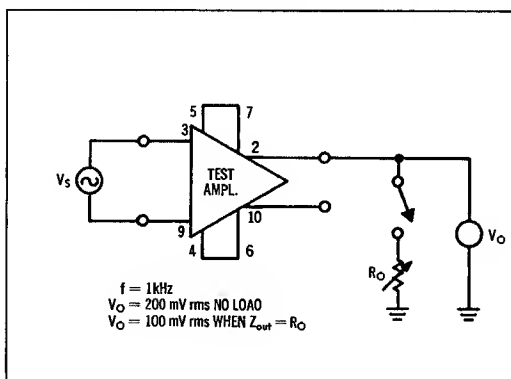
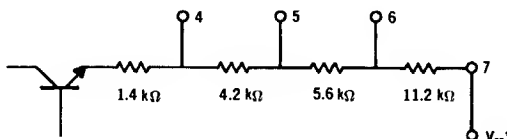


FIGURE 12 — SINGLE-ENDED OUTPUT IMPEDANCE



## BIASING ARRANGEMENT

In the emitter of the current source transistor of each of the differential amplifiers, there are four resistors of different values which may be connected in seven ways. The resultant effective resistance in conjunction with a given  $V_{EE}$  makes provision for different current levels. For convenience, the seven methods together with their effective resistances are tabulated below.



\*Pin 7 is connected to the substrate and must be connected to the  $V_{EE}$  supply for proper circuit operation.

METHOD	1	2	3	4	5	6	7
PIN CONNECTIONS	4-7	4-6, 5-7	4-5, 6-7	4-6	4-5	5-6	4,5,6 OPEN
EFFECTIVE RESISTANCE	1.4 kΩ	3.37 kΩ	7.0 kΩ	12.6 kΩ	18.2 kΩ	16.8 kΩ	22.4 kΩ

EFFECT OF TEMPERATURE ON CHARACTERISTICS

FIGURE 13 — DIFFERENTIAL MODE GAIN

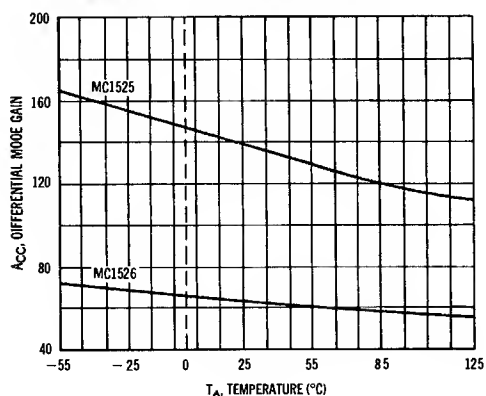


FIGURE 14 — OUTPUT VOLTAGE-COMMON MODE

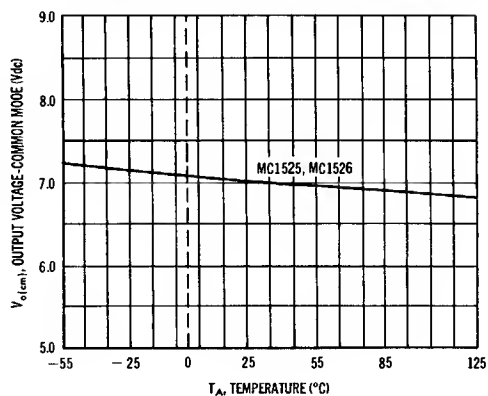


FIGURE 15 — INPUT OFFSET VOLTAGE

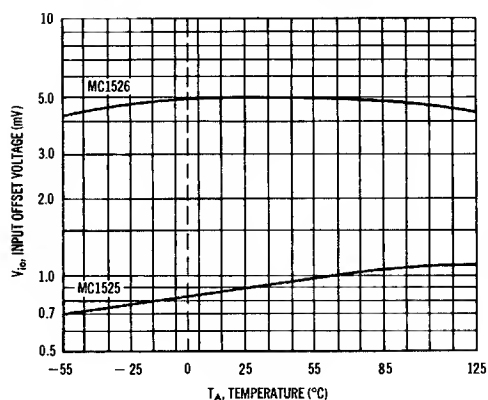


FIGURE 16 — INPUT OFFSET CURRENT

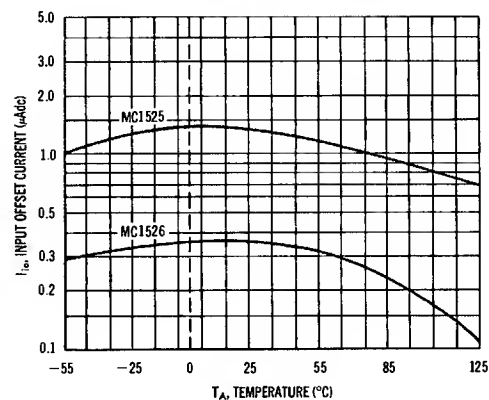


FIGURE 17 — COMMON MODE REJECTION

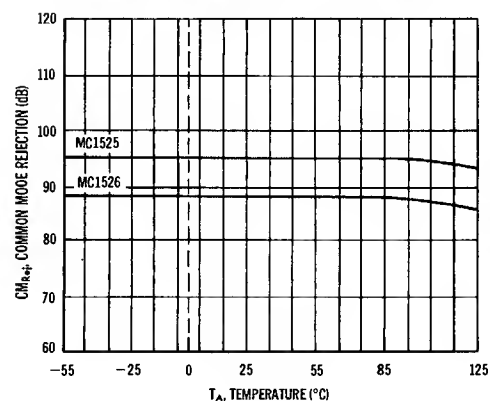
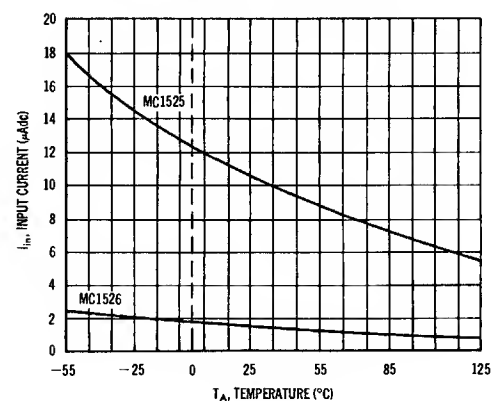


FIGURE 18 — INPUT CURRENT



## DIFFERENTIAL AMPLIFIER

## DIFFERENTIAL AMPLIFIERS

### MC1529G MC1429G

... designed for high-gain applications.  
Features built-in temperature compensated current source for excellent temperature stability.



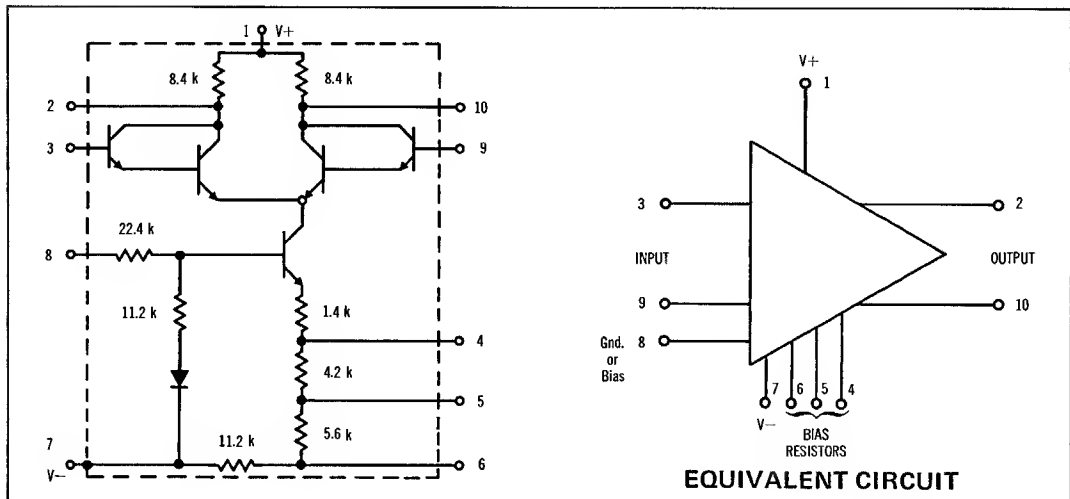
CASE 71

Lead 7 connected to case

#### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	V	+14	Vdc
Power Supply Voltage	V	-14	Vdc
Differential Input Signal	$V_{in}$	$\pm 5$	Vdc
Operating Temperature Range MC1529G MC1429G	$T_A$	-55 to 125 0 to 75	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to 150	$^\circ\text{C}$
Power Dissipation (Package Limitation) Derate above $T_A = 25^\circ\text{C}$	$P_D$	680 4.6	mW mW/ $^\circ\text{C}$

#### CIRCUIT SCHEMATICS

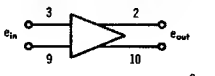
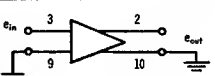
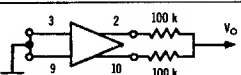
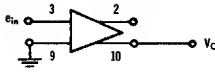
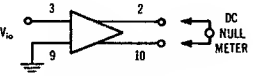
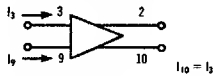
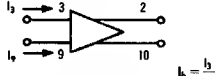
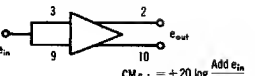
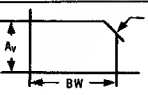
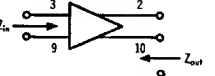
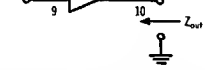


## MC1529G, MC1429G (continued)

### ELECTRICAL CHARACTERISTICS

( $V_+ = +12$  Vdc;  $V_- = -12$  Vdc;  $V_G = 0$  Vdc;  $T_A = 25^\circ\text{C}$  unless otherwise noted)

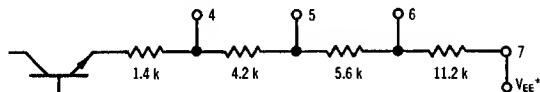
Connect pin 4 to pin 6 and pin 5 to pin 7 for all tests.

Characteristic Definitions*	Characteristic	Symbol	Min	Typ	Max	Unit
 $A_{dd} = \frac{e_{out}}{e_{in}}$	Differential Voltage Gain MC1529G  MC1429G	$A_{dd}$	50 34  45 33	75 —  75 —	110 41  — —	V/V dB  V/V dB
 $A_v = \frac{e_{out}}{e_{in}}$	Single Ended Voltage Gain MC1529G  MC1429G	$A_v$	25 28  22 27	— —  — —	55 35  — —	V/V dB  V/V dB
	Output Voltage, Common Mode MC1529G  MC1429G	$V_{O(CM)}$	6.5  5.5	7.0  7.0	8.5  8.5	Vdc
	Maximum Output Swing Both Types	$V_O$	5.0	—	—	V(p-p)
	Input Offset Voltage MC1529G  MC1429G	$V_{io}$	—  —	—  —	9.0 12.0	mVdc
 $I_{io} = I_3 - I_9$	Input Offset Current MC1529G  MC1429G	$I_{io}$	—  —	—  —	2.0 3.0	$\mu\text{Adc}$
 $I_b = \frac{I_3 + I_9}{2}$	Input Bias Current MC1529G  MC1429G	$I_{in}$	—  —	—  —	4.0 4.0	$\mu\text{Adc}$
 $CM_{Rej} = +20 \log \frac{A_{dd}}{A_{cm}}$	Common Mode Rejection Both Types	$CM_{Rej}$	70	—	—	dB
	Bandwidth MC1529G  MC1429G	BW	200  150	300 250	— —	kHz
	Differential Input Impedance MC1529G  MC1429G	$Z_{in}$	40 30	— —	— —	k $\Omega$
	Single Ended Output Impedance MC1529G  MC1429G	$Z_{out}$	— —	— —	12 15	k $\Omega$

\*All definitions imply linear operation.

### BIASING ARRANGEMENT

In the emitter of the current source transistor of each of the differential amplifiers, there are four resistors of different values which may be connected in seven ways. The resultant effective resistance in conjunction with a given  $V_{EE}$  makes provision for different current levels. For convenience, the seven methods together with their effective resistances are tabulated below.



\*Pin 7 is connected to the substrate and must be connected to the  $V_{EE}$  supply for proper circuit operation.

METHOD	1	2	3	4	5	6	7
PIN CONNECTIONS	4-7	4-6, 5-7	4-5, 6-7	4-6	4-5	5-6	4,5,6 OPEN
EFFECTIVE RESISTANCE	1.4 k	3.37 k	7.0 k	12.6 k	18.2 k	16.8 k	22.4 k

## EFFECT OF TEMPERATURE ON CHARACTERISTICS

FIGURE 1 — DIFFERENTIAL MODE GAIN

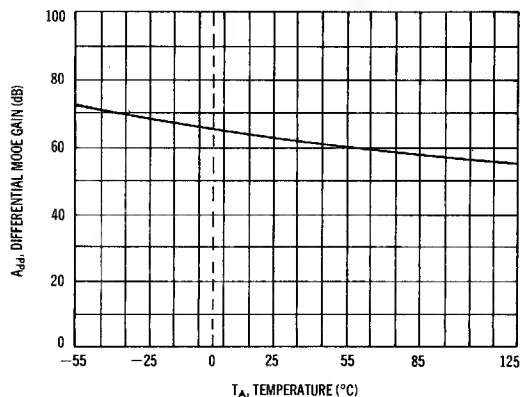


FIGURE 2 — OUTPUT VOLTAGE-COMMON MODE

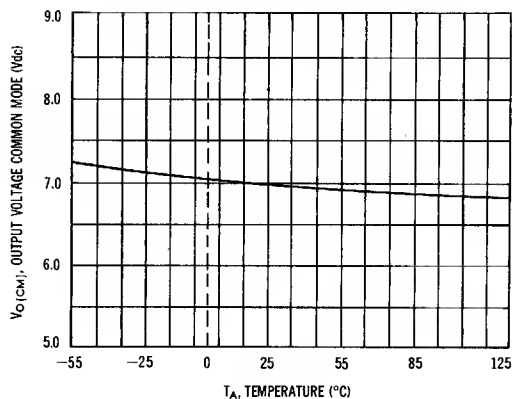


FIGURE 3 — INPUT OFFSET VOLTAGE

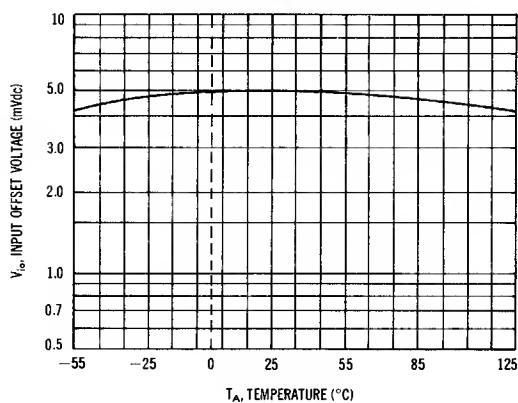


FIGURE 4 — INPUT OFFSET CURRENT

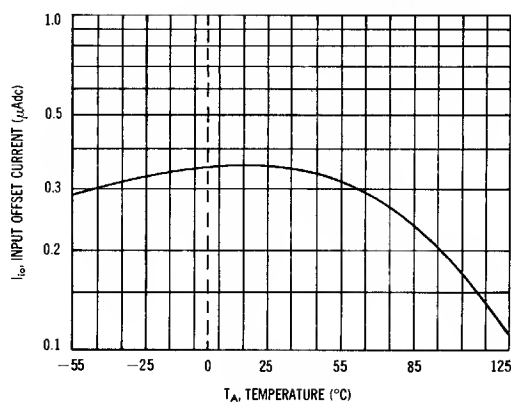


FIGURE 5 — COMMON MODE REJECTION

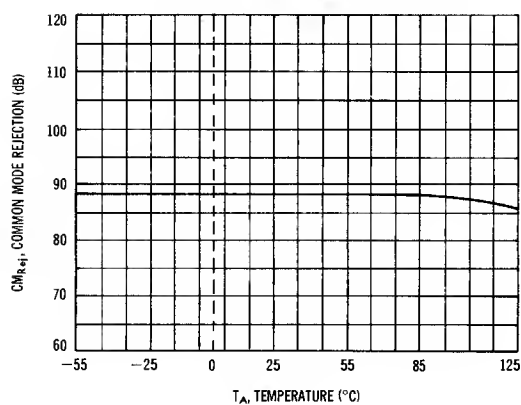
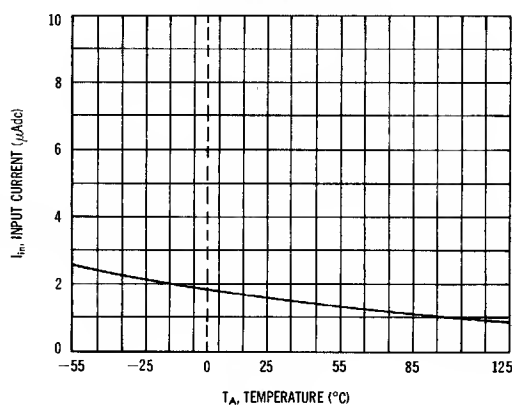


FIGURE 6 — INPUT CURRENT



## MC1440

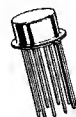
... consisting of a wideband differential amplifier, a dc restoration circuit which also incorporates facilities to externally adjust the threshold, and an MDTL output gate which is strobed from saturated logic. It is designed to detect bipolar differential signals derived by a core memory with cycle times as low as  $0.5 \mu\text{s}$ .

## Typical Amplifier Features:

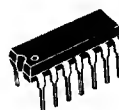
- Differential Threshold Characteristics:
  - Adjustable Threshold — 10-25 mV
  - Nominal Threshold — 17 mV @  $V_6 = -6 \text{ V}$
  - Input Offset Voltage — 1.0 mV typical
  - Threshold Drift —  $-10 \mu\text{V}/^\circ\text{C}$  typical
- Fast Response Time — 20 ns typical
- Short Recovery Time
  - 60 ns max @  $e_{in} = 1.8 \text{ V}$  Common Mode
  - 90 ns max @  $e_{in} = 400 \text{ mV}$  Differential Mode

MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

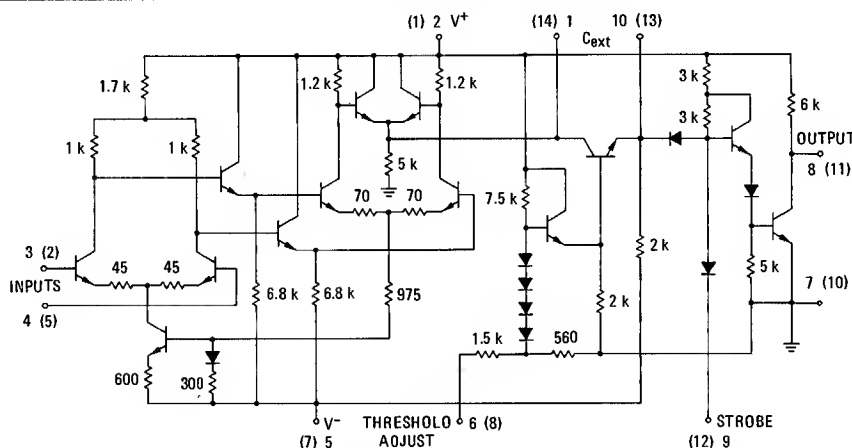
Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$	+10	Vdc
	$V^-$	-10	Vdc
Differential Input Signal	$V_{in}$	$\pm 5$	Vdc
Common Mode Input Voltage	$CMV_{in}$	$\pm 5$	Vdc
Load Current	$I_L$	25	mA
Power Dissipation (Package Limitation)	$P_D$		
Metal Can		680	mW
Derate above $25^\circ\text{C}$		4.6	mW/ $^\circ\text{C}$
Flat Package		500	mW
Derate above $25^\circ\text{C}$		3.3	mW/ $^\circ\text{C}$
Plastic Package		415	mW
Derate above $25^\circ\text{C}$		3.3	mW/ $^\circ\text{C}$
Operating Temperature Range	$T_A$	0 to +75	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$

CASE 71  
"G" SUFFIX

Lead 5 connected to case

CASE 72  
(TO-91)  
"F" SUFFIXCASE 93  
(TO-116)  
"P" SUFFIX

## CIRCUIT SCHEMATIC



Number at end of terminal represents pin number for devices in flat package and metal can.

Number in parenthesis represents pin number for plastic package.

## MC1440 (continued)

### ELECTRICAL CHARACTERISTICS

( $V^+ = +6 \text{ Vdc} \pm 1\%$ ,  $V^- = -6 \text{ Vdc} \pm 1\%$ ,  $C_{\text{ext}} = 0.01 \mu\text{F}$ ,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Pin numbers shown for devices in flat package and metal can. See block diagram for plastic pin numbers.

Characteristic	Fig. No.	Symbol	Min	Typ	Max	Unit
Input Threshold Voltage ( $V_6 = -6 \text{ Vdc}$ )	1	$V_{\text{th}}$	12.0	17.0	22.0	mV
Input Offset Voltage	1	$V_{\text{io}}$	-	1.0	6.0	mV
Input Bias Current ( $V_3 = V_4 = 0$ )	2	$I_b$	-	7.5	75	$\mu\text{A}$
Input Offset Current	2	$I_{\text{io}}$	-	2.0	15.0	$\mu\text{A}$
Output Voltage, High ( $V_3 = V_4 = 0$ )	3	$V_{\text{OH}}$	5.8	-	-	Vdc
Output Voltage Low ( $V_3 = V_4 = 0$ , $V_{10} = +6 \text{ Vdc}$ , $I_8 = 6 \text{ mAdc}$ )	3	$V_{\text{OL}}$	-	-	400	mVdc
Amplifier Voltage Gain ( $V_3 = 15 \text{ mV peak}$ )	4	$A_v$	-	85	-	-
Strobe Load Current ( $V_9 = 0$ )	-	$I_s$	-	-	1.5	mAdc
Strobe Reverse Current ( $V_9 = +5 \text{ Vdc}$ )	-	$I_R$	-	-	5.0	$\mu\text{Adc}$
Power Dissipation	-	$P_D$	-	120	250	mW
Propagation Delay Input to Amplifier Output ( $V_3 = 25 \text{ mV pulse}$ , $V_9 = +2 \text{ Vdc}$ )	5	$t_{3+10+}$	-	10	20	ns
Input to Gate Output ( $V_3 = 25 \text{ mV pulse}$ , $V_9 = +2 \text{ Vdc}$ )	5	$t_{3+8-}$	-	20	50	
Strobe to Gate Output ( $V_3 = V_4 = 0$ , $V_9 = +2 \text{ V pulse}$ )	6	$t_{9+8-}$	-	10	30	
Recovery Time Differential Mode ( $V_3 = 300 \text{ mV pulse}$ )	7	$t_{R(\text{dm})}$	-	20	90	ns
Common Mode ( $V_3 = 1.5 \text{ V pulse}$ )	7	$t_{R(\text{cm})}$	-	20	60	

#### TESTS AT $0^\circ\text{C}$ OR $+75^\circ\text{C}$ AS NOTED

Input Threshold Voltage ( $V_6 = -6.0 \text{ V}$ , $T_A = 0^\circ\text{C}$ ) ( $V_6 = -6.0 \text{ V}$ , $T_A = +75^\circ\text{C}$ )	1	$V_{\text{th}}$	10.0 10.0	17.0 17.0	30.0 30.0	mV
Input Bias Current ( $V_3 = V_4 = 0$ , $T_A = 0^\circ\text{C}$ )	2	$I_b$	-	-	100	$\mu\text{A}$
Output Voltage, Low ( $V_{10} = +6 \text{ Vdc}$ , $I_8 = 6 \text{ mAdc}$ , $T_A = +75^\circ\text{C}$ )	3	$V_{\text{OL}}$	-	-	450	mVdc
Strobe Reverse Current ( $V_9 = +6 \text{ Vdc}$ , $T_A = +75^\circ\text{C}$ )	-	$I_R$	-	-	30	$\mu\text{Adc}$

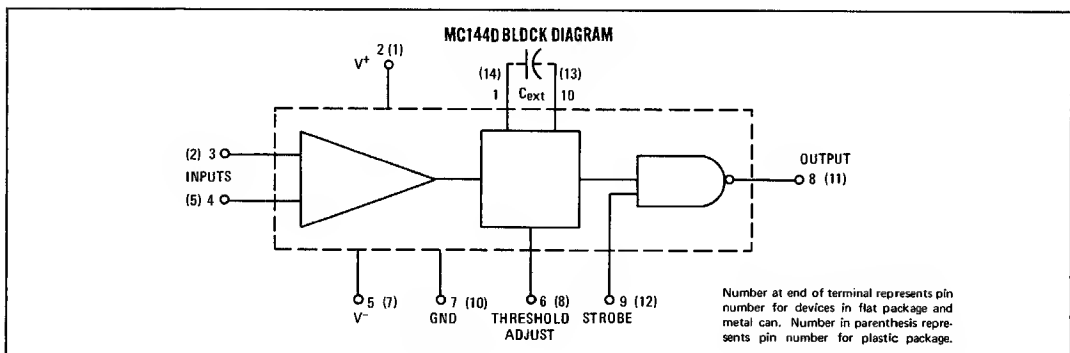




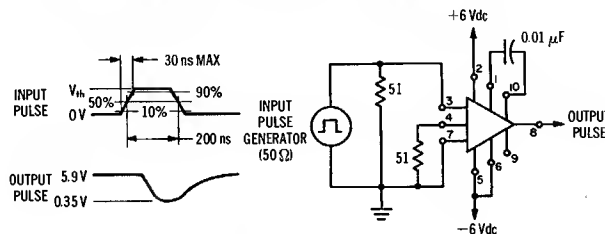
FIGURE 1 — INPUT THRESHOLD AT OUTPUT VOLTAGE SWING FROM  $V_{OL}$  TO  $V_{OH}$ 

FIGURE 2 — INPUT BIAS CURRENT TEST CIRCUIT

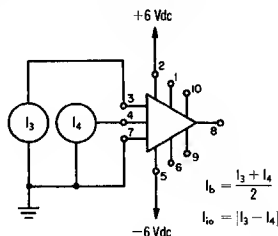


FIGURE 3 — OUTPUT VOLTAGE LEVELS

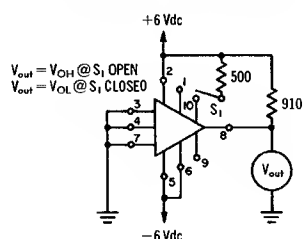


FIGURE 4 — AMPLIFIER VOLTAGE GAIN

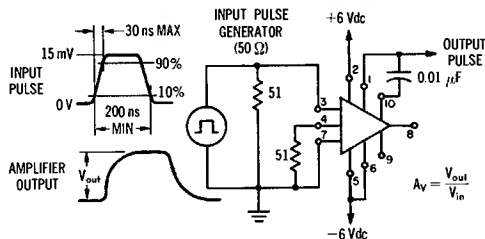


FIGURE 5 — PROPAGATION DELAY (STROBE HIGH)

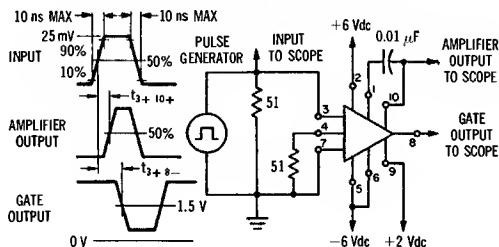


FIGURE 6 — PROPAGATION DELAY (STROBE INPUT)

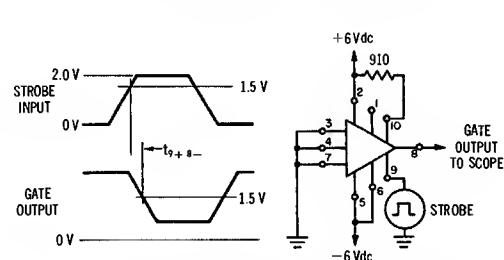


FIGURE 7 — DIFFERENTIAL MODE RECOVERY TIME TEST CIRCUIT

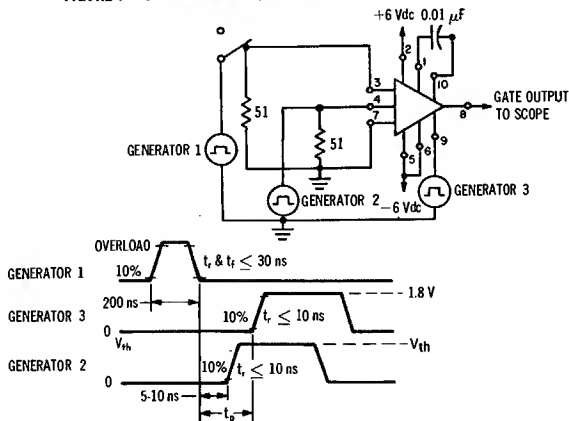
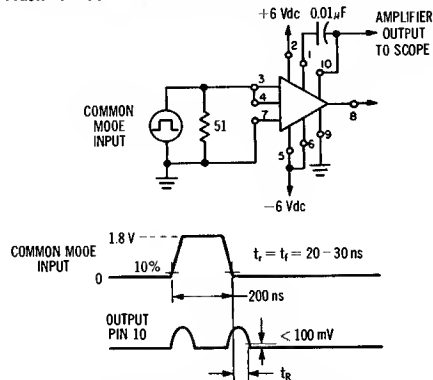


FIGURE 8 — COMMON MODE RECOVERY TIME TEST CIRCUIT



NOTE: The output shown is representative of that obtained. However, the two pulse amplitudes may not be equal or even present.

Pin numbers shown for devices in flat package and metal can. See block diagram for plastic package pin numbers.

FIGURE 9 — TYPICAL TRANSFER CHARACTERISTICS

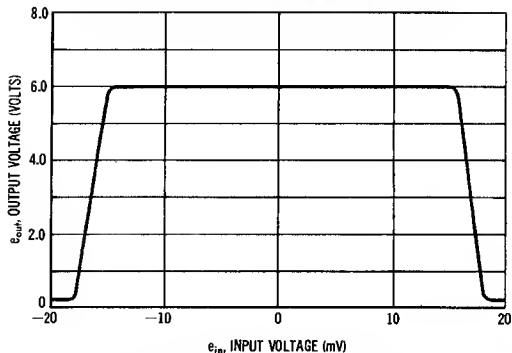
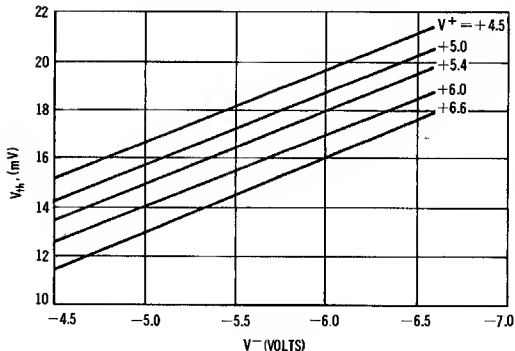
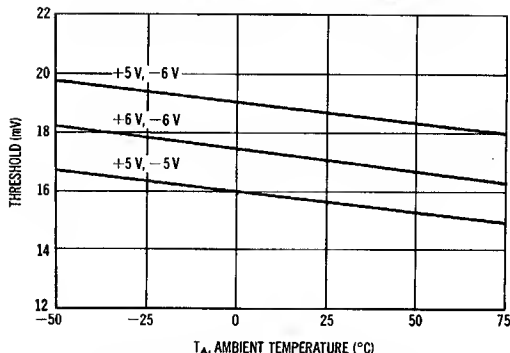
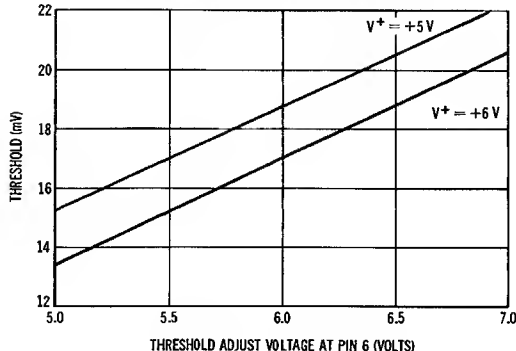
FIGURE 11 — TYPICAL THRESHOLD versus POWER SUPPLIES  
 $T_A = +25^\circ\text{C}$  (Threshold Adjust Attached to  $V^-$ )

FIGURE 10 — TYPICAL THRESHOLD versus TEMPERATURE

FIGURE 12 — TYPICAL THRESHOLD versus THRESHOLD  
VOLTAGE ADJUST FOR  $V^- = -6.0\text{V}$ 

## DEFINITIONS

$A_V$	Amplifier Voltage Gain — The ratio of output voltage at pin 1 to the input voltage at pin 3 or 4.
$I_b$	Input Bias Current — The average input current defined as $(I_3 + I_4)/2$ .
$I_{io}$	Input Offset Current — The difference between input current values, $ I_3 - I_4 $ .
$I_R$	Strobe Reverse Current — The leakage current when the strobe input is high.
$I_S$	Strobe Load Current — The amount of current drain from the circuit when the strobe pin is grounded.
$P_D$	Power Dissipation — The amount of power dissipated in the unit as defined by $ I_2 \times V^+  +  I_5 \times V^- $ .
$t_R$	Recovery Time — The time required for the device to recover from the specified differential and common-mode overload inputs prior to strobe as referenced to the 10% point of the

trailing edge of an input pulse. The device is considered recovered when the threshold after a differential overload disturbance is within 1.0 mV of the threshold value without the disturbance, or, for common-mode disturbance, when the level at pin 10 is within 100 mV of the quiescent value.

$t_{x \pm y \pm}$  Propagation Delay — The time required for the output pulse at pin y to achieve 50% of its final value or the 1.5 V level referenced to 50% of the input pulse at pin x. (The + and - denote positive and negative-going pulse transition.)

$V_{OH}$  Output Voltage High — The high-level output voltage when the output gate is turned off.

$V_{OL}$  Output Voltage Low — The low-level output voltage when the output gate is turned on.

$V_{th}$  Input Threshold — Input pulse amplitude that causes the output to begin saturation.

$V_{io}$  Input Offset Voltage — The difference in  $V_{th}$  at each input.

For a more detailed discussion regarding application of sense amplifiers, see Application Note AN-245A,  
"The MC1540 — An Integrated Core Memory Sense Amplifier."

## MC1540

... consisting of a wideband differential amplifier, a dc restoration circuit which also incorporates facilities to externally adjust the threshold, and an MDTL output gate which is strobed from saturated logic. It is designed to detect bipolar differential signals derived by a core memory with cycle times as low as 0.5  $\mu$ s.

## Typical Amplifier Features:

- Differential Threshold Characteristics:

Adjustable Threshold — 10-25 mV

Nominal Threshold — 17 mV @

$V_G = -6$  V

Input Offset Voltage — 1.0 mV  
typical

Threshold Drift —  $-10 \mu\text{V}/^\circ\text{C}$

- Fast Response Time — 20 ns typical

- Short Recovery Time

50 ns max @  $e_{in} = 1.8$  V Common  
Mode

50 ns max @  $e_{in} = 400$  mV  
Differential Mode



CASE 71  
"G" SUFFIX



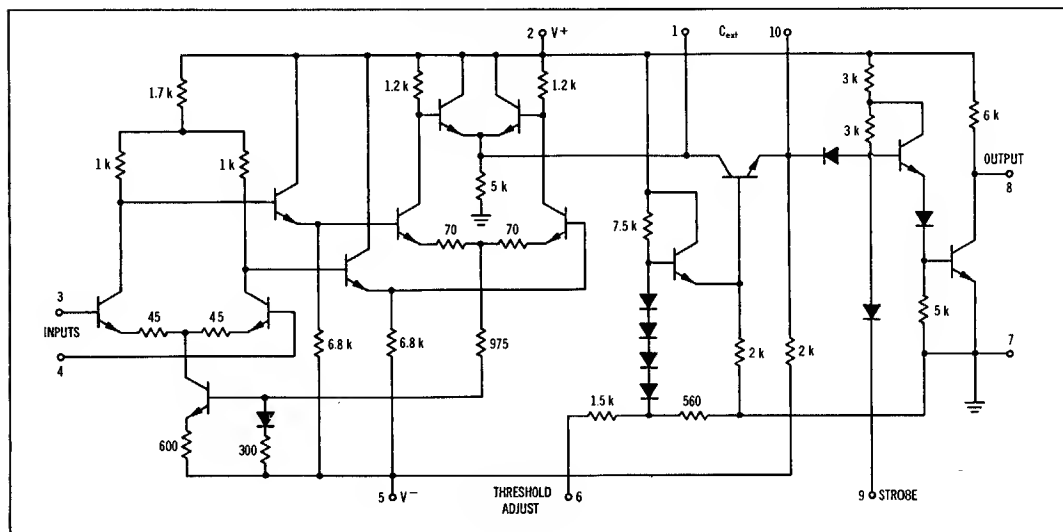
CASE 72  
(TO-91)  
"F" SUFFIX

Lead 5 connected to case

MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$	+10	V <sub>dc</sub>
	$V^-$	-10	V <sub>dc</sub>
Differential Input Signal	$V_{in}$	$\pm 5.0$	V <sub>dc</sub>
Common Mode Input Voltage	$CMV_{in}$	$\pm 5.0$	V <sub>dc</sub>
Load Current	$I_L$	25	mA
Power Dissipation (Package Limitation)			
Metal Can	$P_D$	680	mW
Derate above $25^\circ\text{C}$		4.6	mW/ $^\circ\text{C}$
Flat Package		500	mW
Derate above $25^\circ\text{C}$		3.3	mW/ $^\circ\text{C}$
Operating Temperature Range			$^\circ\text{C}$
Metal Can	$T_A$	-55 to +125	
Flat Package		-55 to +100	
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$

## CIRCUIT SCHEMATIC



**ELECTRICAL CHARACTERISTICS**(V<sup>+</sup> = +6 Vdc ±1%, V<sup>-</sup> = -6 Vdc ±1%, C<sub>ext</sub> = 0.01 μF, T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
Input Threshold Voltage (V <sub>6</sub> = -6.0 V)	1	V <sub>th</sub>	14.0	17.0	20.0	mV
Input Offset Voltage	1	V <sub>io</sub>	—	1.0	5.0	mV
Input Bias Current (V <sub>3</sub> = V <sub>4</sub> = 0)	2	I <sub>b</sub>	—	7.5	50	μA
Input Offset Current	2	I <sub>io</sub>	—	2.0	10.0	μA
Output Voltage, High (V <sub>3</sub> = V <sub>4</sub> = 0)	3	V <sub>OH</sub>	5.9	—	—	Vdc
Output Voltage, Low (V <sub>3</sub> = V <sub>4</sub> = 0, V <sub>10</sub> = +6 Vdc, I <sub>8</sub> = 6 mAdc)	3	V <sub>OL</sub>	—	—	350	mVdc
Amplifier Voltage Gain (V <sub>3</sub> = 15 mV)	4	A <sub>V</sub>	—	85	—	—
Strobe Load Current (V <sub>9</sub> = 0)	—	I <sub>S</sub>	—	—	1.2	mAdc
Strobe Reverse Current (V <sub>9</sub> = +5 Vdc)	—	I <sub>R</sub>	—	—	2.0	μAdc
Power Dissipation	—	P <sub>D</sub>	—	120	180	mW
Propagation Delay						ns
Input to Amplifier Output (V <sub>3</sub> = 25 mV pulse, V <sub>9</sub> = +2 Vdc)	5	t <sub>3+10+</sub>	—	10	15	
Input to Gate Output (V <sub>3</sub> = 25 mV pulse, V <sub>9</sub> = +2 Vdc)	5	t <sub>3+8-</sub>	—	20	30	
Strobe to Gate Output (V <sub>3</sub> = V <sub>4</sub> = 0, V <sub>9</sub> = +2 V pulse)	6	t <sub>9+8-</sub>	—	10	15	
Recovery Time						ns
Differential Mode (V <sub>3</sub> = 400 mV pulse)	7	t <sub>R(dm)</sub>	—	20	50	
Common Mode (V <sub>3</sub> = 1.8 V pulse)	8	t <sub>R(cm)</sub>	—	20	50	

**TESTS AT -55°C OR +125°C AS NOTED**

Input Threshold Voltage (V <sub>6</sub> = -6.0 V, T <sub>A</sub> = -55°C) (V <sub>6</sub> = -6.0 V, T <sub>A</sub> = +125°C)	1	V <sub>th</sub>	12.0 12.0	17.0 17.0	24.0 22.0	mV
Input Bias Current (V <sub>3</sub> = V <sub>4</sub> = 0, T <sub>A</sub> = -55°C)	2	I <sub>b</sub>	—	—	100	μA
Output Voltage, Low (V <sub>10</sub> = +6 Vdc, I <sub>8</sub> = 6 mAdc, T <sub>A</sub> = +125°C)	3	V <sub>OL</sub>	—	—	400	mVdc
Strobe Reverse Current (V <sub>9</sub> = +6 Vdc, T <sub>A</sub> = +125°C)	—	I <sub>R</sub>	—	—	25	μAdc

**DEFINITIONS**

- A<sub>V</sub>** Amplifier Voltage Gain — The ratio of output voltage at pin 1 to the input voltage at pin 3 or 4.
- I<sub>b</sub>** Input Bias Current — The average input current defined as (I<sub>3</sub> + I<sub>4</sub>)/2.
- I<sub>io</sub>** Input Offset Current — The difference between input current values, |I<sub>3</sub> - I<sub>4</sub>|.
- I<sub>R</sub>** Strobe Reverse Current — The leakage current when the strobe input is high.
- I<sub>S</sub>** Strobe Load Current — The amount of current drain from the circuit when the strobe pin is grounded.
- P<sub>D</sub>** Power Dissipation — The amount of power dissipated in the unit as defined by |I<sub>2</sub> × V<sup>+</sup>| + |I<sub>5</sub> × V<sup>-</sup>|.
- t<sub>R</sub>** Recovery Time — The time required for the device to recover from the specified differential and common-mode overload inputs prior to strobe as referenced to the 10% point of the

trailing edge of an input pulse. The device is considered recovered when the threshold after a differential overload disturbance is within 1.0 mV of the threshold value without the disturbance, or, for common-mode disturbance, when the level at pin 10 is within 100 mV of the quiescent value.

**t<sub>x±y±</sub>** Propagation Delay — The time required for the output pulse at pin y to achieve 50% of its final value or the 1.5 V level referenced to 50% of the input pulse at pin x. (The + and - denote positive and negative-going pulse transition.)

**V<sub>OH</sub>** Output Voltage High — The high-level output voltage when the output gate is turned off.

**V<sub>OL</sub>** Output Voltage Low — The low-level output voltage when the output gate is turned on.

**V<sub>th</sub>** Input Threshold — Input pulse amplitude that causes the output to begin saturation.

**V<sub>io</sub>** Input Offset Voltage — The difference in V<sub>th</sub> at each input.

FIGURE 1 — INPUT THRESHOLD AT OUTPUT VOLTAGE SWING FROM  $V_{OL}$  TO  $V_{OH}$

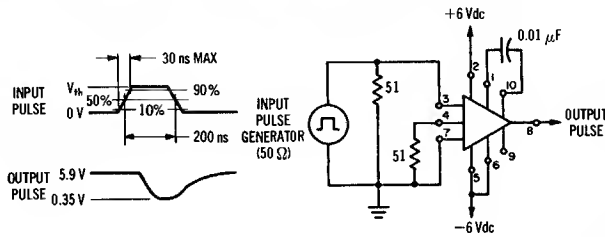


FIGURE 2 — INPUT BIAS CURRENT TEST CIRCUIT

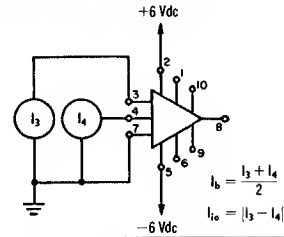


FIGURE 3 — OUTPUT VOLTAGE LEVELS

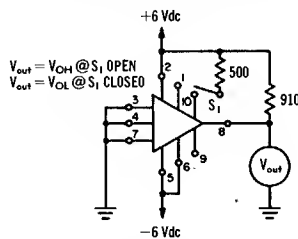


FIGURE 4 — AMPLIFIER VOLTAGE GAIN

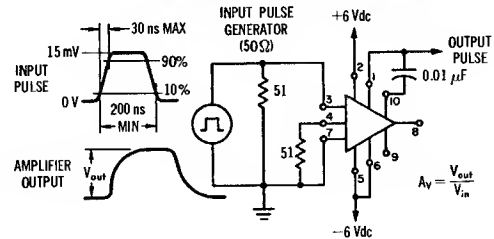


FIGURE 5 — PROPAGATION DELAY (STROBE HIGH)

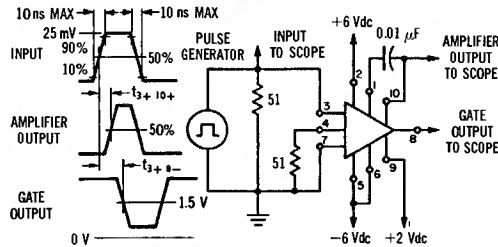


FIGURE 6 — PROPAGATION DELAY (STROBE INPUT)

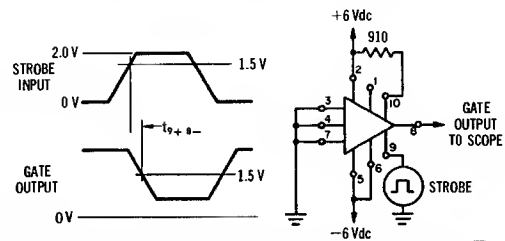


FIGURE 7 — DIFFERENTIAL MODE RECOVERY TIME TEST CIRCUIT

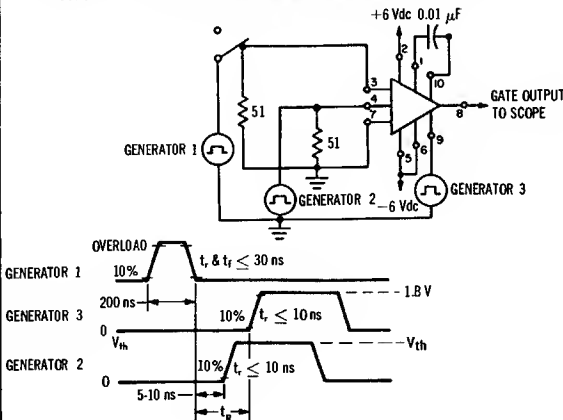
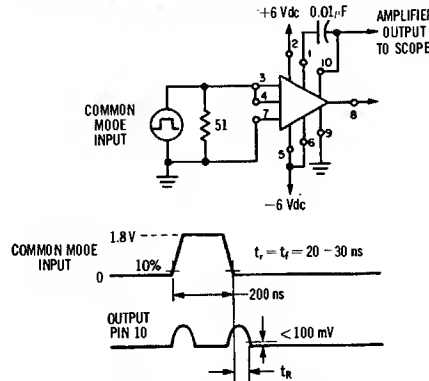


FIGURE 8 — COMMON MODE RECOVERY TIME TEST CIRCUIT



NOTE: The output shown is representative of that obtained. However, the two pulse amplitudes may not be equal or even present.

FIGURE 9 — TYPICAL TRANSFER CHARACTERISTICS

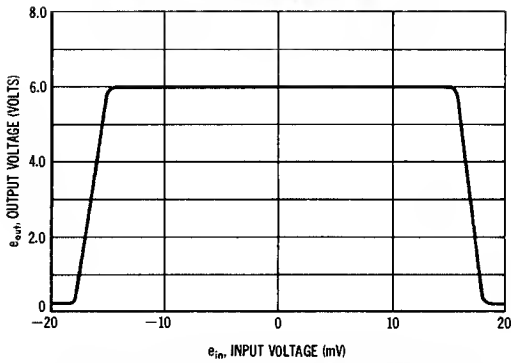


FIGURE 10 — TYPICAL THRESHOLD versus TEMPERATURE

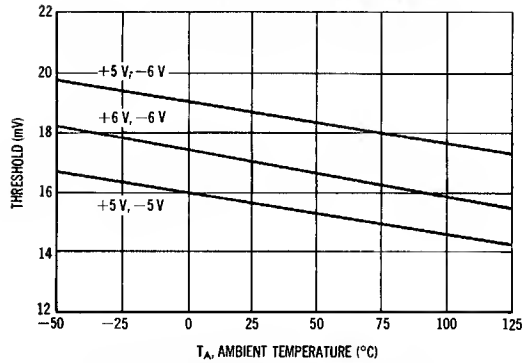


FIGURE 11 — TYPICAL THRESHOLD versus POWER SUPPLIES  
 $T_A = +25^\circ\text{C}$  (Threshold Adjust Attached to  $V^-$ )

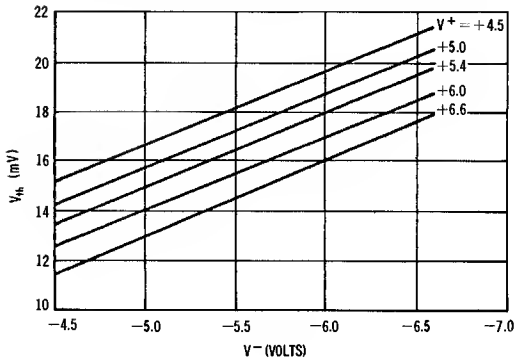


FIGURE 12 — TYPICAL THRESHOLD versus THRESHOLD  
VOLTAGE ADJUST FOR  $V^- = -6.0\text{V}$

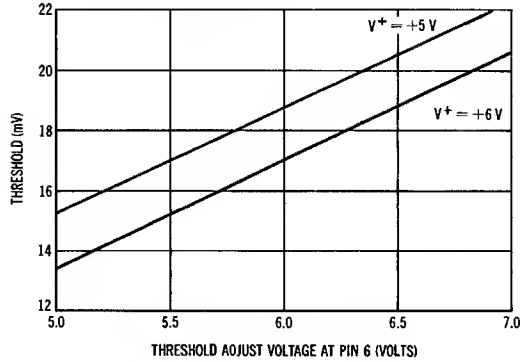
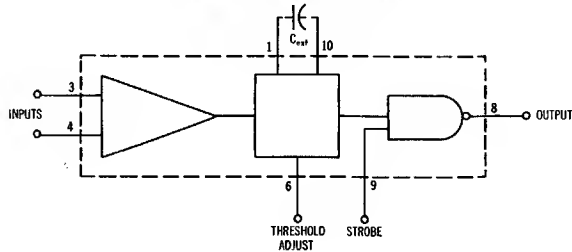


FIGURE 13 — MC1540 BLOCK DIAGRAM



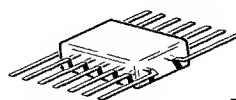
For a more detailed discussion regarding application of sense amplifiers, see Application Note AN-245A, "The MC1540 — An Integrated Core Memory Sense Amplifier."

**MC1541F**

Dual-channel gated sense amplifier with separate wideband differential input amplifiers. Either input can be gated on from saturated logic levels. The sense amplifier features adjustable threshold, saturated logic output levels, and a strobe input that accommodates saturated logic levels. Designed to detect bipolar signals from either of two sense lines. Operates with core memory cycle times less than 0.5  $\mu$ s.

**Typical Amplifier Features:**

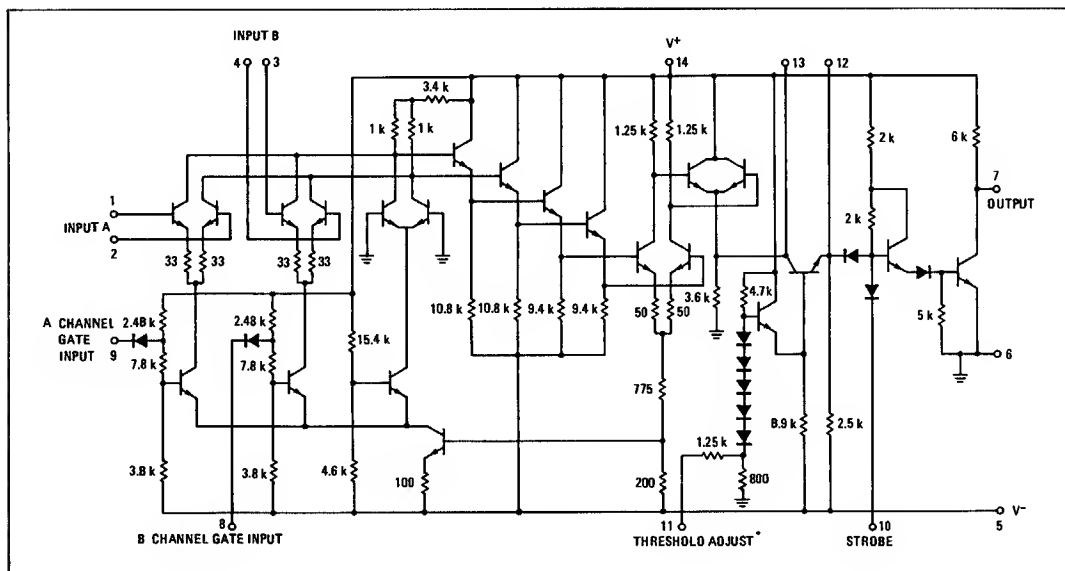
- Nominal Threshold – 17 mV
- Input Offset Voltage – 1.0 mV typical
- Propagation Delay
  - Input to Gate-Output – 20 ns
  - Input to Amplifier-Output – 10 ns
  - Gate Response Time – 15 ns
  - Strobe Response Time – 15 ns
- Common Mode Input Range – 1.5 Volts
- Differential Mode Input Range
  - With Gate On – 600 mV
  - With Gate Off – 1.5 Volts
- Power Dissipation – 140 mW typical



TO-86  
CASE 83

**MAXIMUM RATINGS** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$	+10	Vdc
	$V^-$	-10	Vdc
Differential Input Signal	$V_{in}$	$\pm 5$	Vdc
Common Mode Input Voltage	$CMV_{in}$	$\pm 5$	Vdc
Load Current	$I_L$	25	mA
Power Dissipation (Package Limitation) Derate above $25^\circ\text{C}$	$P_D$	500	mW
		3.3	mW/ $^\circ\text{C}$
Operating Temperature Range	$T_A$	$-55$ to $+125$	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	$-65$ to $+150$	$^\circ\text{C}$

**CIRCUIT SCHEMATIC**

## MC1541F (continued)

### ELECTRICAL CHARACTERISTICS

( $V^+ = +5.0 \text{ Vdc} \pm 1\%$ ,  $V^- = -5.0 \text{ Vdc} \pm 1\%$ ,  $V_{th}(\text{pin 11}) = -5.0 \text{ Vdc} \pm 1\%$ ,  $C_{ext} = 0.01 \mu\text{F}$ ,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Fig. No.	Symbol	Min	Typ	Max	Unit
Input Threshold Voltage ( $T_A = +25^\circ\text{C}$ ) ( $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ )	8	$V_{th}$	14 12	17 17	20 22	mV
Input Offset Voltage	8	$V_{io}$	-	1.0	6.0	mV
Input Bias Current ( $V_1 = V_2 = V_3 = V_4 = 0$ ) ( $V_1 = V_2 = V_3 = V_4 = 0$ , $T_A = -55^\circ\text{C}$ )	9	$I_b$	- -	5.0 -	25 50	$\mu\text{A}$
Input Offset Current	9	$I_{io}$	-	1.0	2.0	$\mu\text{A}$
Output Voltage High ( $V_1 = V_2 = V_3 = V_4 = 0$ )	10	$V_{OH}$	4.9	-	-	Vdc
Output Voltage Low ( $V_1 = V_2 = V_3 = V_4 = 0$ , $V_{12} = +5.0 \text{ Vdc}$ , $I_7 = 10 \text{ mAdc}$ ) ( $V_{12} = +5.0 \text{ Vdc}$ , $I_7 = 10 \text{ mAdc}$ , $T_A = +125^\circ\text{C}$ )	10	$V_{OL}$	- -	- -	350 400	mVdc
Stroke Load Current ( $V_{10} = 0$ )		$I_S$	-	-	1.2	mAdc
Stroke Reverse Current ( $V_{10} = +5.0 \text{ Vdc}$ ) ( $V_{10} = +5.0 \text{ Vdc}$ , $T_A = +125^\circ\text{C}$ )		$I_{SR}$	- -	- -	2.0 25	$\mu\text{Adc}$
Input Gate Voltage Low ( $V_1 = V_3 = 25 \text{ mVdc}$ , $V_2 = V_4 = 0$ )	11	$V_{GL}$	-	0.7	-	Vdc
Input Gate Voltage High ( $V_1 = V_3 = 25 \text{ mVdc}$ , $V_2 = V_4 = 0$ )	11	$V_{GH}$	-	1.6	-	Vdc
Input Gate Load Current ( $V_8$ or $V_9 = 0$ )		$I_G$	-	-	2.5	mAdc
Input Gate Reverse Current ( $V_8$ or $V_9 = 5.0 \text{ Vdc}$ ) ( $T_A = 25^\circ\text{C}$ ) ( $T_A = +125^\circ\text{C}$ )		$I_{GR}$	- -	- -	2.0 25	$\mu\text{Adc}$
Common Mode Range Input Gate High Input Gate Low	13	$V_{CM}$	- -	$\pm 1.5$ $\pm 1.5$	- -	Vdc
Differential Mode Range Input Gate High Input Gate Low	14	$V_{DH}$ $V_{DL}$	- -	$\pm 600$ $\pm 1.5$	- -	mV Vdc
Power Dissipation		$P_D$	-	140	180	mW

### SWITCHING CHARACTERISTICS

Characteristic	Fig. No.	Symbol	Min	Typ	Max	Unit
Propagation Delay Input to Amplifier Output ( $V_1 = 25 \text{ mV pulse}$ , $V_{10} = +2.0 \text{ Vdc}$ )	8	$t_{IA}$	-	10	15	ns
Input to Output ( $V_1 = 25 \text{ mV pulse}$ , $V_{10} = +2.0 \text{ Vdc}$ )	8	$t_{IO}$	-	20	30	
Stroke to Output ( $V_1 = V_2 = V_3 = V_4 = 0$ , $V_{10} = +2.0 \text{ V pulse}$ )	12	$t_{SO}$	-	15	20	
Gate Input to Amplifier Input ( $V_1 = 25 \text{ mV pulse}$ , $V_9 = 2.0 \text{ V pulse}$ )	11	$t_{GI}$	-	10	15	
Gate Input to Amplifier Output ( $V_1 = 25 \text{ mVdc}$ , $V_9 = 2.0 \text{ V pulse}$ )	11	$t_{GA}$	-	30	35	
Recovery Time Differential Mode Input Gate High } $V_1$ or $V_3 = 400 \text{ mV pulse}$ Input Gate Low }	14	$t_{DR}$	- -	30 0	50 -	ns
Common Mode Input Gate High } $V_1$ or $V_3 = 1.5 \text{ V pulse}$ Input Gate Low }	13	$t_{CMR}$	- -	15 15	30 30	



EQUIVALENT CIRCUIT

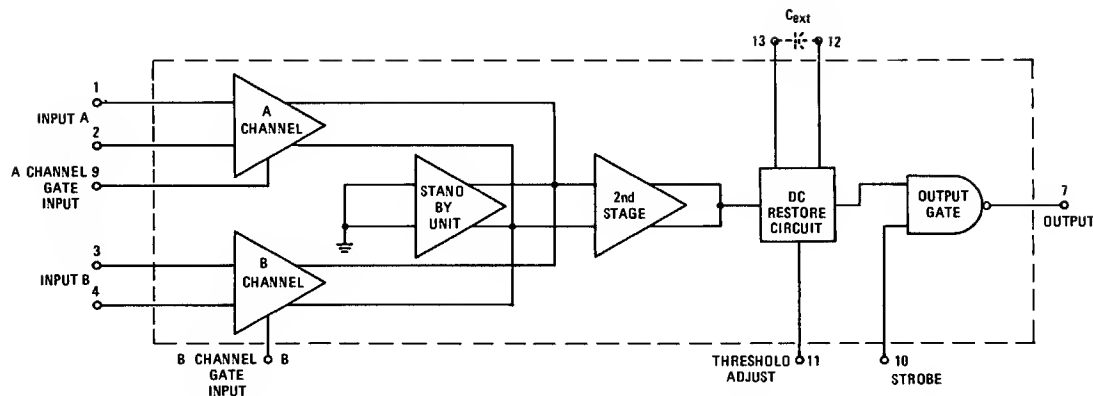


FIGURE 1 – TYPICAL OPERATION

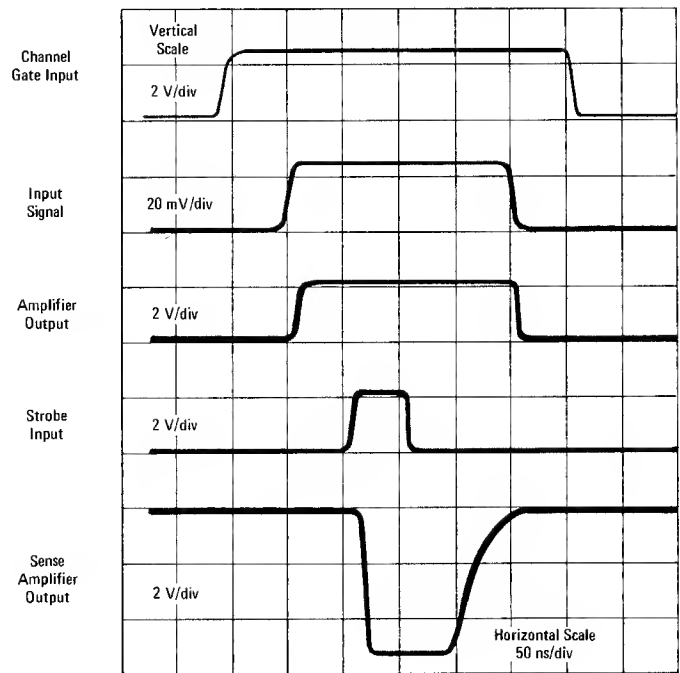


FIGURE 2 – TYPICAL INPUT THRESHOLD versus TEMPERATURE

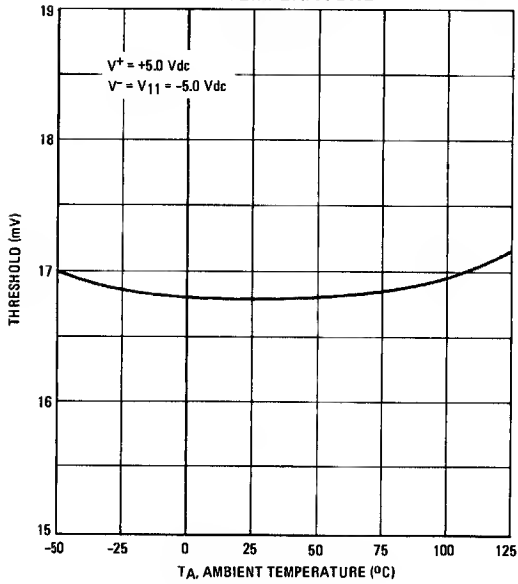


FIGURE 3 – TYPICAL THRESHOLD versus THRESHOLD VOLTAGE ADJUST

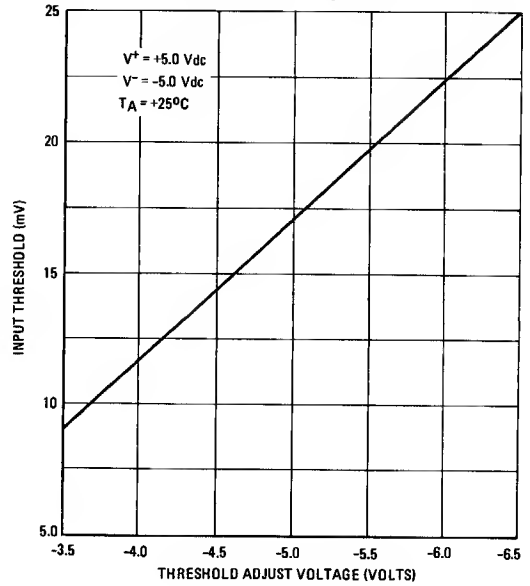


FIGURE 4 – TYPICAL INPUT THRESHOLD versus  $V^-$

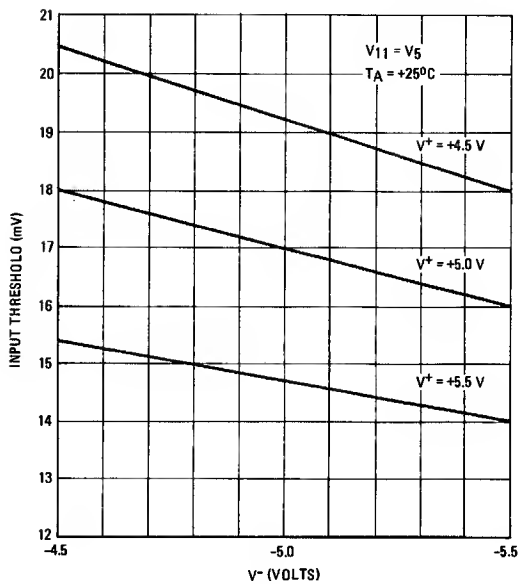


FIGURE 5 – TYPICAL INPUT THRESHOLD versus INPUT PULSE WIDTH

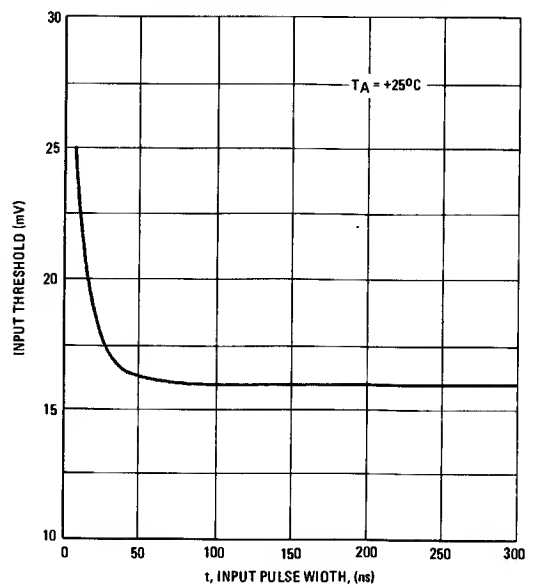


FIGURE 6 – INPUT-OUTPUT TRANSFER CHARACTERISTICS

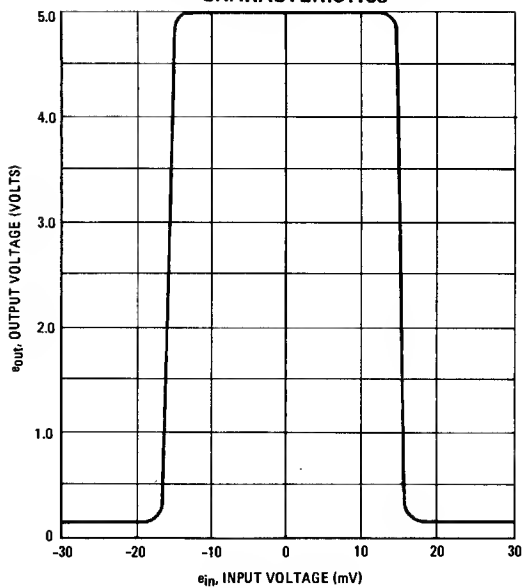


FIGURE 7 – CHANNEL GATE INPUT-AMPLIFIER OUTPUT TRANSFER CHARACTERISTICS

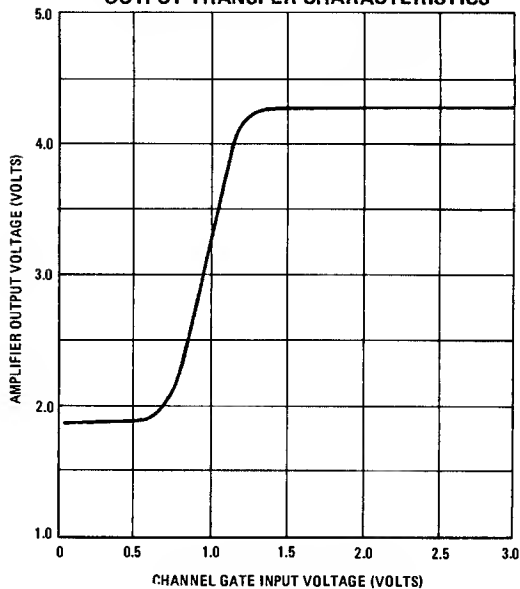
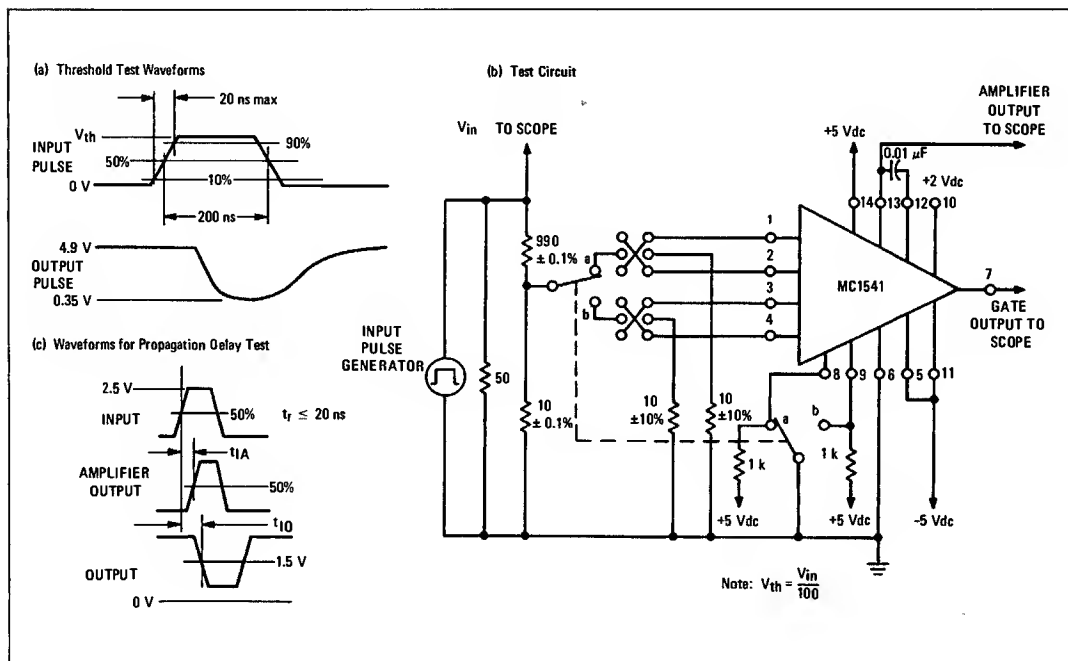


FIGURE 8 – INPUT THRESHOLD FOR OUTPUT VOLTAGE SWING FROM  $V_{OH}$  TO  $V_{OL}$   
PROPAGATION DELAY FROM INPUT TO OUTPUT



# MC1541F (continued)

FIGURE 9 – INPUT BIAS CURRENT TEST CIRCUIT

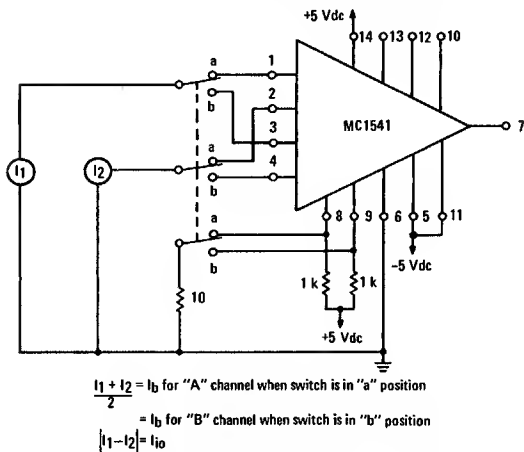


FIGURE 10 – OUTPUT VOLTAGE LEVELS

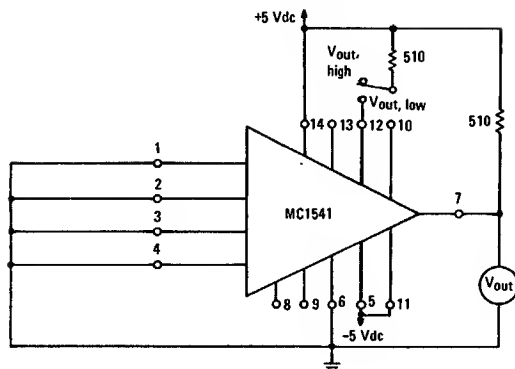


FIGURE 11 – MINIMUM TIME FROM CHANNEL GATE INPUT TO AMPLIFIER INPUT  
PROPAGATION DELAY FROM CHANNEL GATE INPUT TO AMPLIFIER OUTPUT

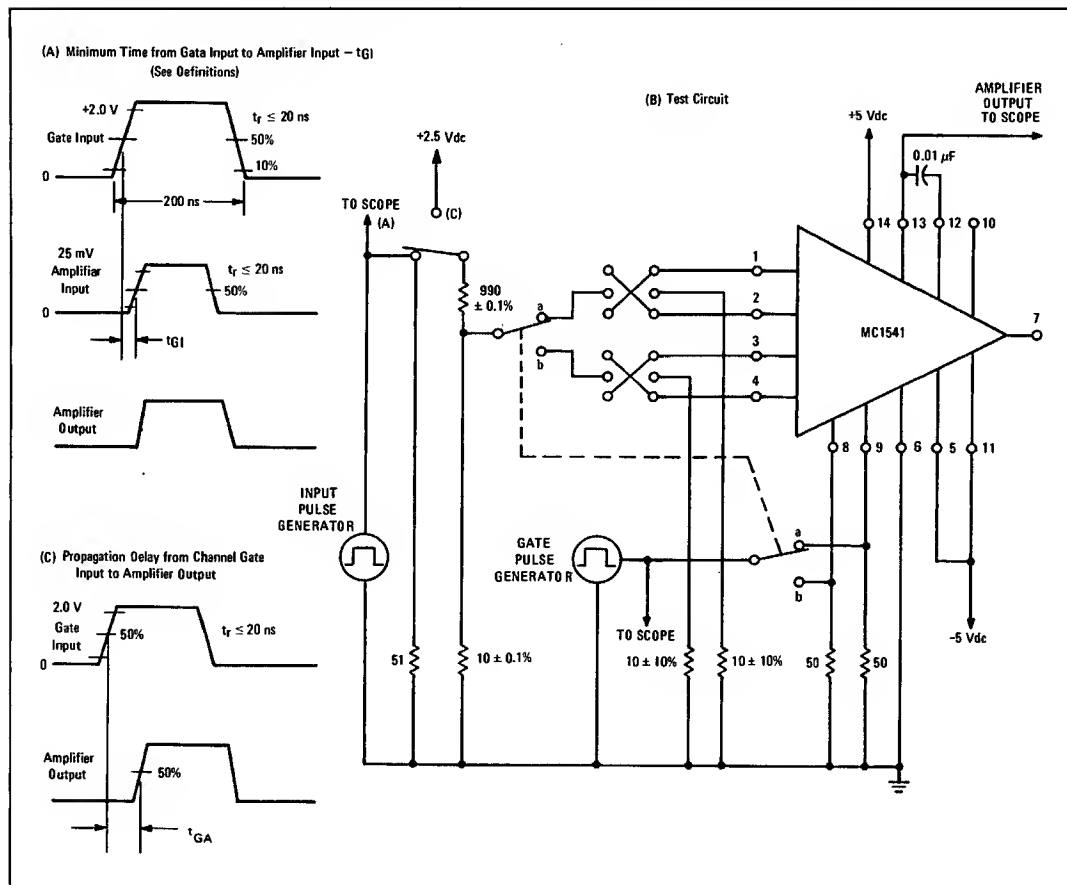


FIGURE 12 – PROPAGATION DELAY FROM STROBE INPUT TO OUTPUT

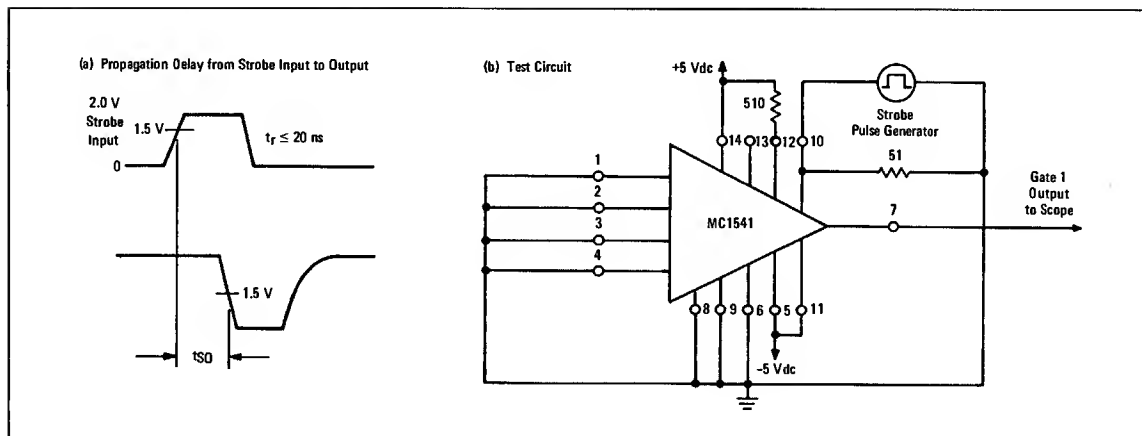


FIGURE 13 – COMMON MODE RECOVERY AND COMMON MODE RANGE

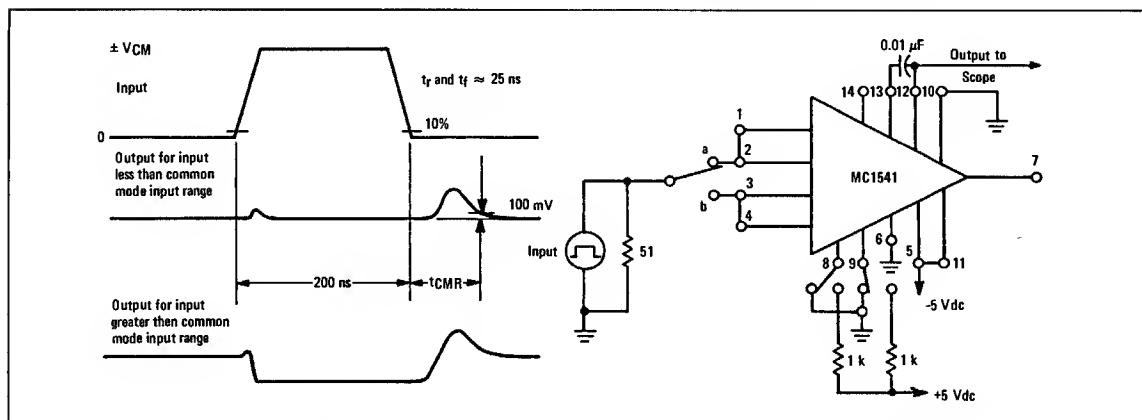
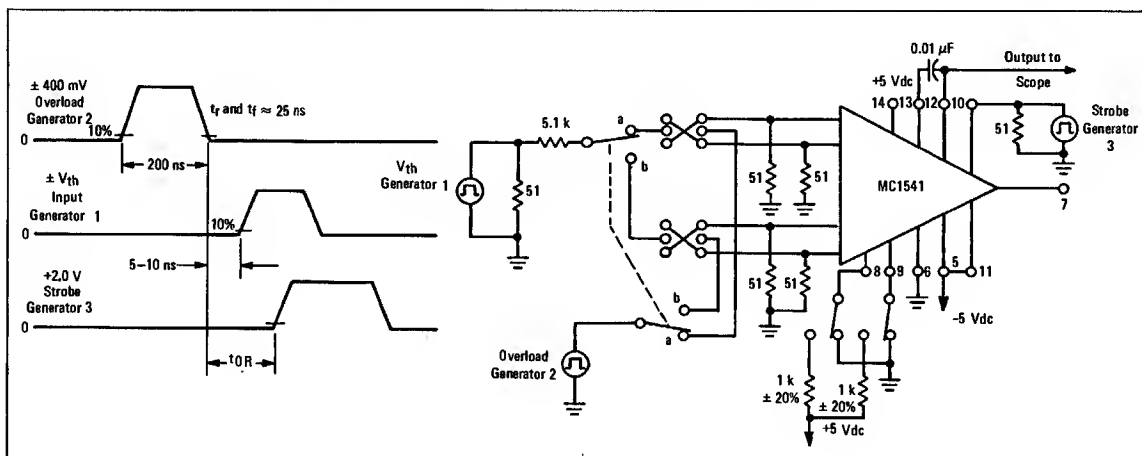


FIGURE 14 – DIFFERENTIAL RECOVERY AND DIFFERENTIAL RANGE



## DEFINITIONS

<b>I<sub>B</sub></b>	Input Bias Current — The average input current defined as $(I_1 + I_2 + I_3 + I_4)/4$ .		
<b>I<sub>G</sub></b>	Channel Gate Load Current — The amount of current drain from the circuit when the channel gate input (Pin 8 or 9) is grounded.	<b>t<sub>IO</sub></b>	Propagation Delay, Input to Output — The time required for the gate output pulse at pin 7 to reach the 1.5 Volt level as referenced to 50% of the input pulse at pins 1 and 2 or 3 and 4.
<b>I<sub>GR</sub></b>	Channel Gate Reverse Current — The leakage current when the channel gate input (Pin 8 or 9) is high.	<b>t<sub>SO</sub></b>	Strobe Propagation Delay to Output — The time required for the output pulse at pin 7 to reach the 1.5 Volt level as referenced to the 1.5 Volt level of the strobe input at pin 10.
<b>I<sub>io</sub></b>	Input Offset Current — The difference between amplifier input current values $ I_1 - I_2 $ or $ I_3 - I_4 $ .	<b>V<sub>CM</sub></b>	Maximum Common Mode Input Range — The common mode input voltage which causes the output voltage level of the amplifier to decrease by 100 mV. (This is independent of the channel gate input level.)
<b>I<sub>S</sub></b>	Strobe Load Current — The amount of current drain from the circuit when the strobe pin is grounded.	<b>V<sub>DH</sub></b>	Maximum Differential Input Range, Gate Input High — The differential input which causes the input stage to begin saturation.
<b>I<sub>SR</sub></b>	Strobe Reverse Current — The leakage current when the strobe input is high.	<b>V<sub>DL</sub></b>	Maximum Differential Input Range, Gate Input Low — The differential input signal which causes the output voltage level of the amplifier to decrease by 100 mV.
<b>P<sub>D</sub></b>	Power Dissipation — The amount of power dissipated in the unit.	<b>V<sub>GH</sub></b>	Channel Gate Input Voltage High — Gate pulse amplitude that allows the amplifier output pulse to just reach 100% of its final value. (Amplifier input is set at 25 mVdc).
<b>t<sub>CMR</sub></b>	Common Mode Recovery Time — The time required for the voltage at pin 12 to be within 100 mV of the dc value (after overshoot or ringing) as referenced to the 10% point of the trailing edge of a common mode overload signal.	<b>V<sub>GL</sub></b>	Channel Gate Input Voltage Low — Gate pulse amplitude that allows the amplifier output to just reach a 100 mV level. (Amplifier input is set at 25 mVdc).
<b>t<sub>DR</sub></b>	Differential Recovery Time — The time required for the device to recover from the specified differential input prior to strobe enable as referenced to the 10% point of the trailing edge of an input pulse. The device is considered recovered when the threshold with the overload signal applied is within 1.0 mV of the threshold with no overload input.	<b>V<sub>io</sub></b>	Input Offset Voltage — The difference in $V_{th}$ between inputs at pins 1 and 2 or 3 and 4.
<b>t<sub>GI</sub></b>	Minimum Time Between Channel Gate Input and Signal Input — The minimum time between 50% point of channel gate input (Pin 8 or 9) and 50% point of signal input (Pins 1, 2, 3, or 4) that still allows a full width signal at amplifier output.	<b>V<sub>OH</sub></b>	Output Voltage High — The high-level output voltage when the output gate is turned off.
<b>t<sub>GA</sub></b>	Propagation Delay, Channel Gate Input to Amplifier Output — The time required for the amplifier output at pin 13 to reach 50% of its final value as referenced to 50% of the input gate pulse at pin 8 or 9 (Amplifier input = 25 mVdc).	<b>V<sub>OL</sub></b>	Output Voltage Low — The low-level output voltage when the output gate is saturated and the output sink current is 10 mA.
<b>t<sub>IA</sub></b>	Propagation Delay, Input to Amplifier Output — The time required for the amplifier output	<b>V<sub>th</sub></b>	Input Threshold — Input pulse amplitude at pins 1, 2, 3 or 4 that causes the output gate to just reach $V_{OL}$ .

## DIFFERENTIAL COMPARATOR

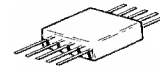
## SENSE AMPLIFIERS

### MC1710

... designed for use in level detection, low-level sensing, and memory applications.

#### Typical Amplifier Features:

- Differential Input Characteristics:  
Input Offset Voltage = 1.0 mV  
Offset Voltage Drift =  $3.0 \mu\text{V}/^\circ\text{C}$
- Fast Response Time — 40 ns
- Output Compatible with All Saturating Logic Forms  
 $V_{\text{out}} = +3.2 \text{ V to } -0.5 \text{ V typical}$
- Low Output Impedance — 200 ohms



CASE 72  
(TO-91)  
"F" SUFFIX



CASE 96  
(TO-99)  
"G" SUFFIX

Lead 4 connected to case

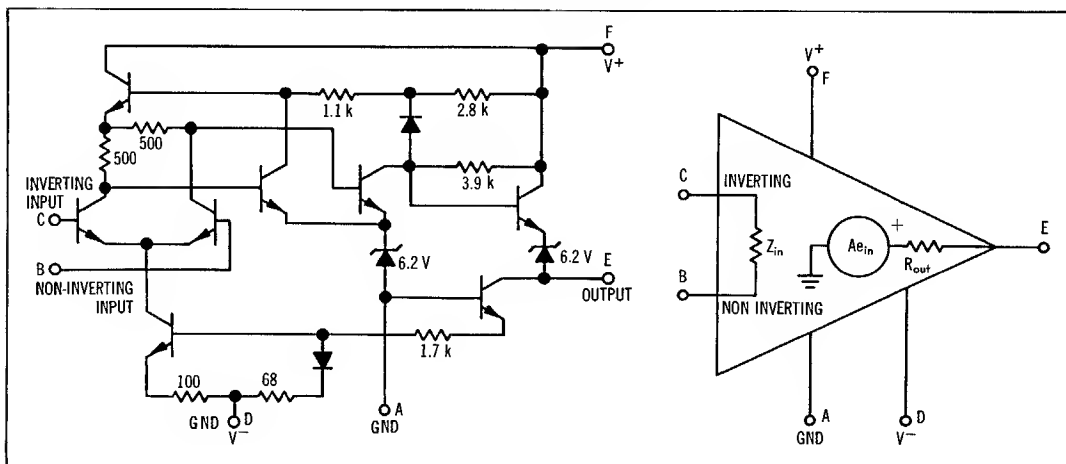
#### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+ 14 - 7.0	Vdc Vdc
Differential Input Signal	$V_{\text{in}}$	$\pm 5.0$	Volts
Common Mode Input Swing	$\text{CMV}_{\text{in}}$	$\pm 7.0$	Volts
Peak Load Current	$I_L$	10	mA
Power Dissipation (package limitation)	$P_D$		
Metal Can		680	mW
Derate above $T_A = 25^\circ\text{C}$		4.6	mW/ $^\circ\text{C}$
Flat Package		500	mW
Derate above $T_A = 25^\circ\text{C}$		3.3	mW/ $^\circ\text{C}$
Operating Temperature Range	$T_A$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{\text{stg}}$	-65 to +150	$^\circ\text{C}$

#### PIN CONNECTIONS

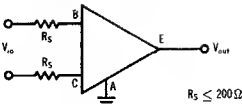
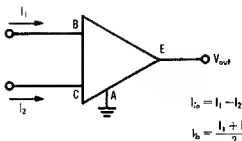
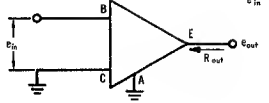
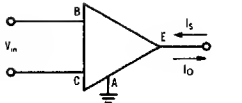
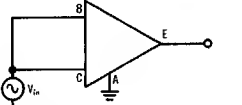
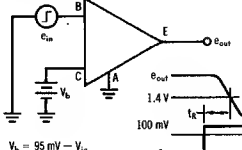
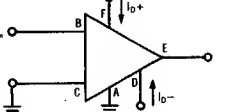
Schematic	A	B	C	D	E	F
"G" Package	1	2	3	4	7	8
"F" Package	1	2	3	5	6	8

#### CIRCUIT SCHEMATIC



# MC1710 (continued)

## ELECTRICAL CHARACTERISTICS ( $V^+ = +12$ Vdc, $V^- = -6$ Vdc, $T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic Definitions	Characteristic	Symbol	Min	Typ	Max	Unit
	Input Offset Voltage $V_{out} = 1.4$ Vdc, $T_A = 25^\circ\text{C}$ $V_{out} = 1.8$ Vdc, $T_A = -55^\circ\text{C}$ $V_{out} = 1.0$ Vdc, $T_A = +125^\circ\text{C}$	$V_{io}$	-	1.0	2.0	mVdc
	Temperature Coefficient of Input Offset Voltage	$TC_{Vio}$	-	3.0	-	$\mu\text{V}/^\circ\text{C}$
	Input Offset Current $V_{out} = 1.4$ Vdc, $T_A = 25^\circ\text{C}$ $V_{out} = 1.8$ Vdc, $T_A = -55^\circ\text{C}$ $V_{out} = 1.0$ Vdc, $T_A = +125^\circ\text{C}$	$I_{io}$	-	1.0	3.0	$\mu\text{Adc}$
	Input Bias Current $V_{out} = 1.4$ Vdc, $T_A = 25^\circ\text{C}$ $V_{out} = 1.8$ Vdc, $T_A = -55^\circ\text{C}$ $V_{out} = 1.0$ Vdc, $T_A = +125^\circ\text{C}$	$I_{bi}$	-	12	20	$\mu\text{Adc}$
	Open Loop Voltage Gain $T_A = 25^\circ\text{C}$ $T_A = -55$ to $+125^\circ\text{C}$	$A_{VOL}$	1250 1000	1700 -	- -	V/V
	Output Resistance	$R_{out}$	-	200	-	ohms
	Differential Voltage Range	$V_{in}$	$\pm 5.0$	-	-	Vdc
	Positive Output Voltage $V_{in} \approx 5.0$ mV, $0 \leq I_o \leq 0.5$ mA	$V_{OH}$	2.5	3.2	4.0	Vdc
	Negative Output Voltage $V_{in} \approx -5.0$ mV	$V_{OL}$	-1.0	-0.5	0	Vdc
	Output Sink Current $V_{in} \approx -5.0$ mV, $V_{out} \approx 0$ , $T_A = 25^\circ\text{C}$ $V_{in} \approx -5.0$ mV, $V_{out} \approx 0$ , $T_A = -55^\circ\text{C}$	$I_s$	2.0 1.0	2.5 2.0	- -	mAdc
	Input Common Mode Range	$CMV_{in}$	$\pm 5.0$	-	-	Volts
	Common Mode Rejection Ratio $V^- = -7.0$ Vdc, $R_S \leq 200\Omega$	$CM_{rej}$	80	100	-	dB
	Response Time For Positive and Negative Going Input Pulse	$t_R$	-	40	-	ns
	Power Supply Current $V_{out} \approx 0$ Vdc	$I_{D+}$ $I_{D-}$	- -	6.4 5.5	9.0 7.0	mAdc
	Power Consumption TO-99 Metal Can TO-91 Flat Package		- -	115 115	150 150	mW



TYPICAL CHARACTERISTICS

FIGURE 1 – VOLTAGE TRANSFER CHARACTERISTICS

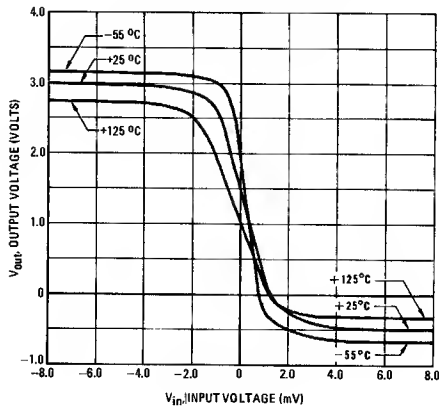


FIGURE 2 – INPUT OFFSET VOLTAGE versus TEMPERATURE

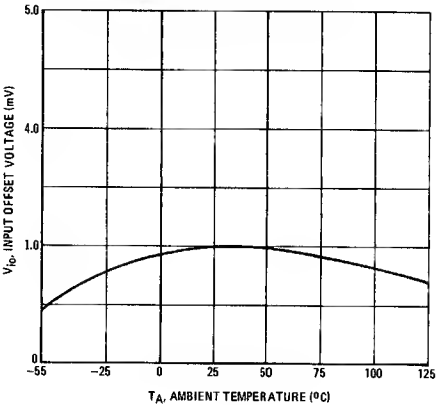


FIGURE 3 – INPUT OFFSET CURRENT versus TEMPERATURE

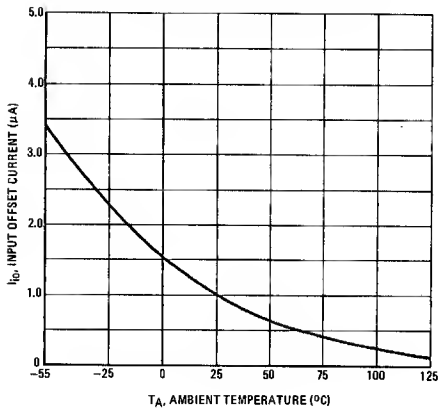


FIGURE 4 – INPUT BIAS CURRENT versus TEMPERATURE

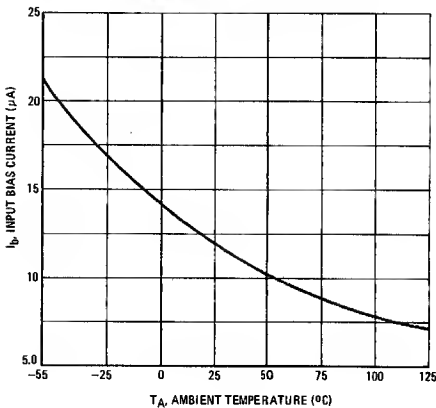


FIGURE 5 – GAIN VARIATION WITH POWER SUPPLY VOLTAGE

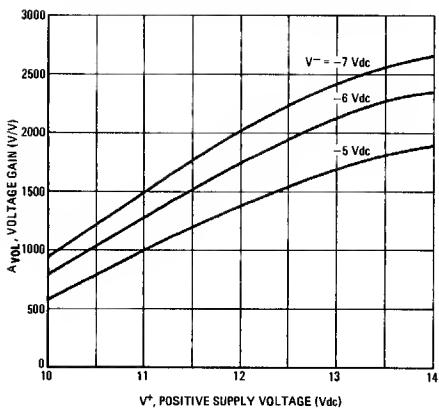
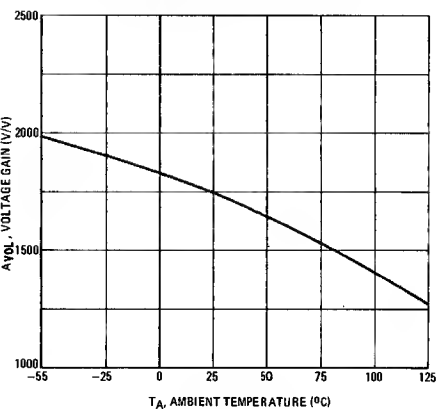


FIGURE 6 – VOLTAGE GAIN versus TEMPERATURE



## MC1710 (continued)

FIGURE 7 – RESPONSE TIME

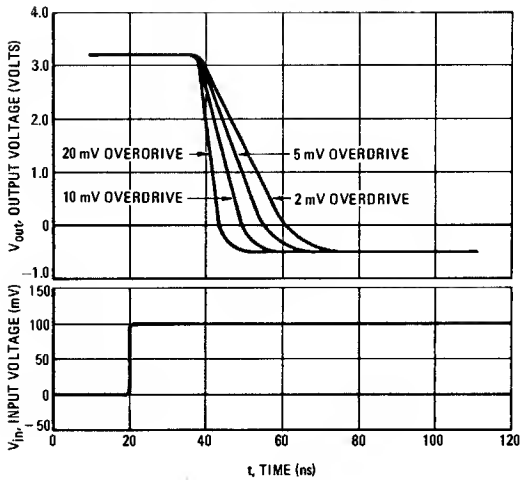


FIGURE 8 – POWER DISSIPATION versus TEMPERATURE

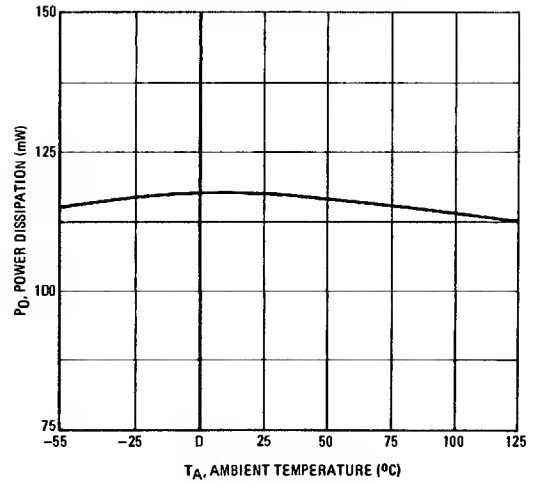


FIGURE 9 – SERIES RESISTANCE versus MRTL FAN-OUTS

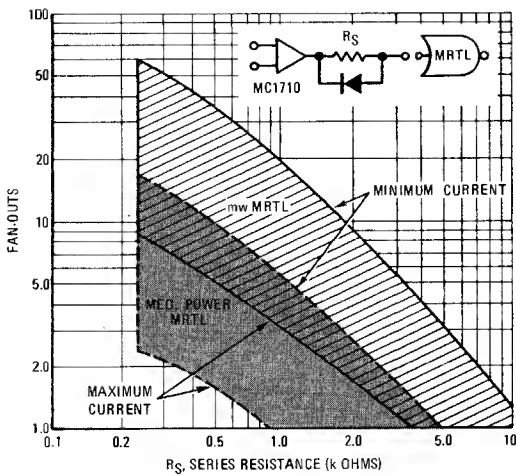
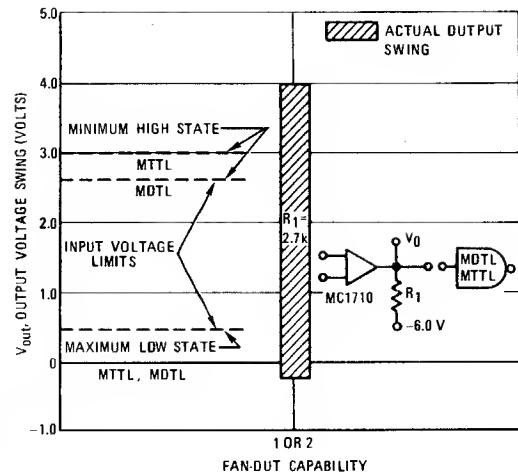


FIGURE 10 – FAN-OUT CAPABILITY WITH MDTL OR MTTL OUTPUT SWING



## DIFFERENTIAL COMPARATOR

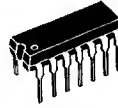
## SENSE AMPLIFIERS

### MC1710C

... designed for use in level detection, low-level sensing, and memory applications.



CASE 72  
(TO-91)  
"F" SUFFIX



CASE 93  
(TO-116)  
"P" SUFFIX

Lead 4 connected  
to case



CASE 96  
(TO-99)  
"G" SUFFIX

#### Typical Amplifier Features:

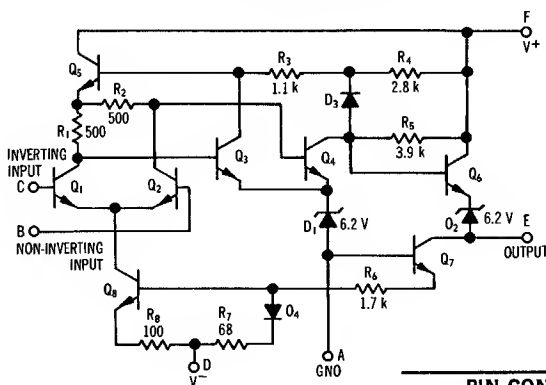
- Differential Input Characteristics:  
Input Offset Voltage = 1.5 mV  
Offset Voltage Drift =  $5.0 \mu\text{V}/^\circ\text{C}$
- Fast Response Time — 40 ns
- Output Compatible with All Saturating Logic Forms  
 $V_{\text{out}} = +3.2 \text{ V}$  to  $-0.5 \text{ V}$  typical
- Low Output Impedance — 200 ohms

#### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+14 -7.0	Vdc Vdc
Differential Input Signal	$V_{\text{in}}$	$\pm 5.0$	Volts
Common Mode Input Swing	$\text{CMV}_{\text{in}}$	$\pm 7.0$	Volts
Peak Load Current	$I_L$	10	mA
Power Dissipation (package limitation)	$P_D$		
Metal Can		680	mW
Derate above $25^\circ\text{C}$		4.6	mW/ $^\circ\text{C}$
Flat Package		500	mW
Derate above $25^\circ\text{C}$		3.3	mW/ $^\circ\text{C}$
Plastic Package		400	mW
Derate above $25^\circ\text{C}$		3.3	mW/ $^\circ\text{C}$
Operating Temperature Range*	$T_A$	0 to +75	$^\circ\text{C}$
Storage Temperature Range	$T_{\text{stg}}$		$^\circ\text{C}$
Metal Can and Flat Package		-65 to +150	
Plastic Package		-65 to +125	

\*For full temperature range ( $-55^\circ\text{C}$  to  $+125^\circ\text{C}$ ) and characteristic curves, see MC1710 data sheet.

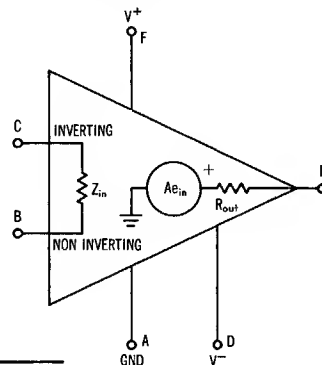
#### CIRCUIT SCHEMATIC



#### PIN CONNECTIONS

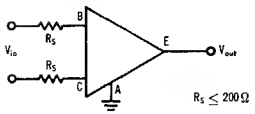
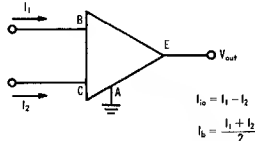
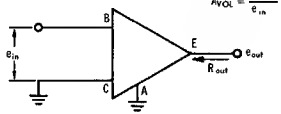
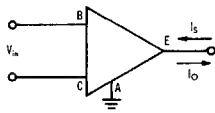
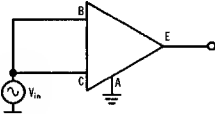
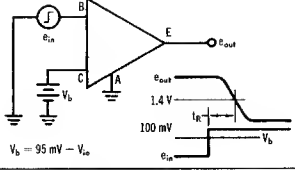
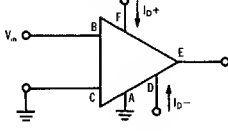
Schematic	A	B	C	D	E	F
"G" Package	1	2	3	4	7	8
"F" Package	1	2	3	5	6	8
"P" Package	2	3	4	6	9	11

#### EQUIVALENT CIRCUIT



# MC1710C (continued)

## ELECTRICAL CHARACTERISTICS (V<sup>+</sup> = +12 Vdc, V<sup>-</sup> = -6 Vdc, T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic Definitions	Characteristic	Symbol	Min	Typ	Max	Unit
	Input Offset Voltage V <sub>out</sub> = 1.4 Vdc, T <sub>A</sub> = 25°C V <sub>out</sub> = 1.5 Vdc, T <sub>A</sub> = 0°C V <sub>out</sub> = 1.2 Vdc, T <sub>A</sub> = +70°C	V <sub>io</sub>	-	1.5	5.0	mVdc
	Temperature Coefficient of Input Offset Voltage	TC <sub>Vio</sub>	-	5.0	-	μV/°C
	Input Offset Current V <sub>out</sub> = 1.4 Vdc, T <sub>A</sub> = 25°C V <sub>out</sub> = 1.5 Vdc, T <sub>A</sub> = 0°C V <sub>out</sub> = 1.2 Vdc, T <sub>A</sub> = +70°C	I <sub>io</sub>	-	1.0	5.0	μAdc
	Input Bias Current V <sub>out</sub> = 1.4 Vdc, T <sub>A</sub> = 25°C V <sub>out</sub> = 1.5 Vdc, T <sub>A</sub> = 0°C V <sub>out</sub> = 1.2 Vdc, T <sub>A</sub> = +70°C	I <sub>b</sub>	-	15	25	μAdc
	Voltage Gain T <sub>A</sub> = 25°C T <sub>A</sub> = 0 to +70°C	A <sub>VOL</sub>	1000	1500	-	V/V
	Output Resistance	R <sub>out</sub>	-	200	-	ohms
	Differential Voltage Range	V <sub>in</sub>	±5.0	-	-	Vdc
	Positive Output Voltage V <sub>in</sub> ≥ 5.0 mV, 0 ≤ I <sub>O</sub> ≤ 0.5 mA	V <sub>OH</sub>	2.5	3.2	4.0	Vdc
	Negative Output Voltage V <sub>in</sub> ≤ -5.0 mV	V <sub>OL</sub>	-1.0	-0.5	0	Vdc
	Output Sink Current V <sub>in</sub> ≤ -5.0 mV, V <sub>out</sub> ≥ 0 T <sub>A</sub> = 25°C T <sub>A</sub> = 0°C	I <sub>s</sub>	1.6	2.5	-	mAdc
	Input Common Mode Range V <sup>-</sup> = -7.0 Vdc	CMV <sub>in</sub>	±5.0	-	-	Volts
	Common Mode Rejection Ratio R <sub>S</sub> ≤ 200 Ω	CM <sub>rej</sub>	70	100	-	dB
	Propagation Delay Time For Positive and Negative Going Input Pulse	t <sub>pd</sub>	-	40	-	ns
	Power Supply Current V <sub>out</sub> ≤ 0 Vdc	I <sub>D</sub> <sup>+</sup> I <sub>D</sub> <sup>-</sup>	-	6.4	9.0	mAdc
	Power Consumption		-	110	150	mW

# DUAL DIFFERENTIAL COMPARATOR

# SENSE AMPLIFIERS

## MC1711

... designed for use in level detection, low-level sensing, and memory applications.



Lead 5 connected to case

CASE 71 A  
"G" SUFFIX



CASE 72  
(TO-91)  
"F" SUFFIX

### Typical Amplifier Features:

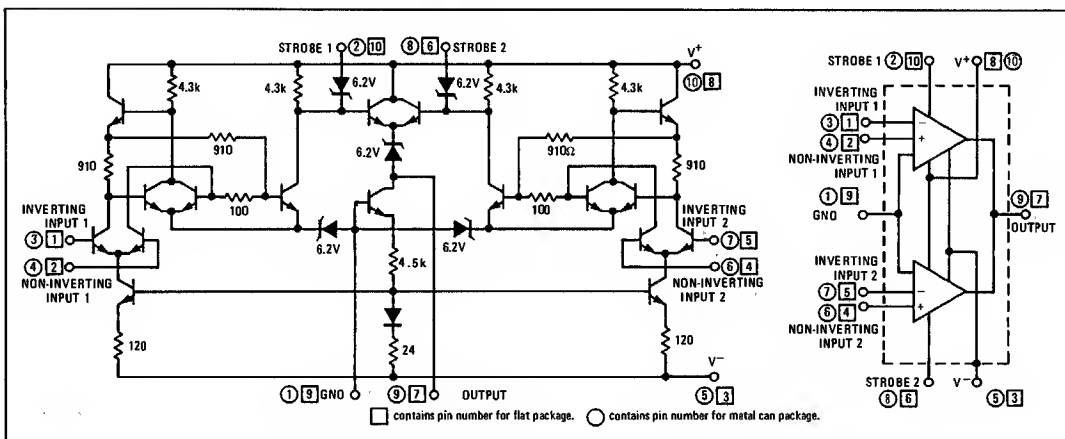
- Differential Input –  
Input Offset Voltage = 1.0 mV  
Offset Voltage Drift = 5.0  $\mu\text{V}/^\circ\text{C}$
- Fast Response Time – 40 ns
- Output Compatible with All Saturating Logic Forms  
 $V_{\text{out}} = +4.5 \text{ V}$  to  $-0.5 \text{ V}$  typical
- Low Output Impedance – 200 ohms

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+14 -7.0	Vdc Vdc
Differential Input Signal	$V_{\text{in}}$	$\pm 5.0$	Volts
Common Mode Input Swing	$\text{CMV}_{\text{in}}$	$\pm 7.0$	Volts
Peak Load Current	$I_L$	50	mA
Power Dissipation (package limitation)	$P_D$	680 4.6	mW $\text{mW}/^\circ\text{C}$
Metal Can Derate above $T_A = 25^\circ\text{C}$			
Flat Package Derate above $T_A = 25^\circ\text{C}$		500 3.3	mW $\text{mW}/^\circ\text{C}$
Operating Temperature Range	$T_A$	-55 to +125	$^\circ\text{C}$
Storage Temperature Range	$T_{\text{stg}}$	-65 to +150	$^\circ\text{C}$

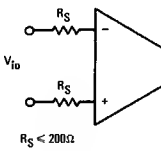
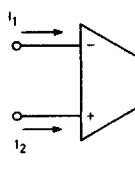
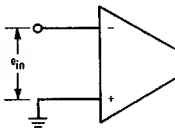
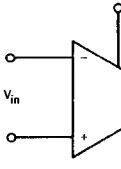
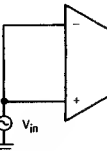
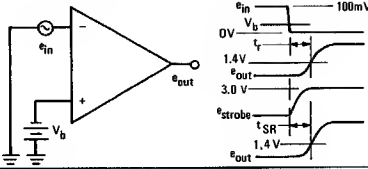
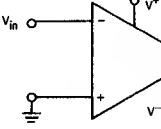
### CIRCUIT SCHEMATIC

### EQUIVALENT CIRCUIT



# MC1711 (continued)

ELECTRICAL CHARACTERISTICS (each comparator)  $V^+ = +12$  Vdc,  $V^- = -6.0$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic Definitions	Characteristic	Symbol	Min	Typ	Max	Unit
 <p> <math>V_{io}</math>  <math>R_S &lt; 200\Omega</math>  <math>V_{out} = 1.4</math> Vdc @ <math>+25^\circ\text{C}</math>  <math>V_{out} = 1.8</math> Vdc @ <math>55^\circ\text{C}</math>  <math>V_{out} = 1.0</math> Vdc @ <math>+125^\circ\text{C}</math> </p>	Input Offset Voltage $CMV_{in} = 0$ Vdc, $T_A = +25^\circ\text{C}$ $T_A = +25^\circ\text{C}$ $CMV_{in} = 0$ Vdc, $T_A = -55$ to $+125^\circ\text{C}$ $T_A = -55$ to $+125^\circ\text{C}$	$V_{io}$	-	1.0	3.5	mVdc
	Temperature Coefficient of Input Offset Voltage	$TC_{Vio}$	-	5.0	-	$\mu\text{V}/^\circ\text{C}$
 <p> <math>I_1</math>  <math>I_2</math>  <math>I_{io} = I_1 - I_2</math>  <math>I_b = \frac{I_1 + I_2}{2}</math> </p>	Input Offset Current $V_{out} = 1.4$ Vdc, $T_A = +25^\circ\text{C}$ $V_{out} = 1.8$ Vdc, $T_A = -55^\circ\text{C}$ $V_{out} = 1.0$ Vdc, $T_A = +125^\circ\text{C}$	$I_{io}$	-	0.5	10	$\mu\text{Adc}$
	Input Bias Current $V_{out} = 1.4$ Vdc, $T_A = +25^\circ\text{C}$ $V_{out} = 1.8$ Vdc, $T_A = -55^\circ\text{C}$ $V_{out} = 1.0$ Vdc, $T_A = +125^\circ\text{C}$	$I_b$	-	25	75	$\mu\text{Adc}$
 <p> <math>A_{VOL} = \frac{e_{out}}{e_{in}}</math>  <math>R_{out}</math> </p>	Voltage Gain $T_A = +25^\circ\text{C}$ $T_A = -55$ to $+125^\circ\text{C}$	$A_{VOL}$	750	1500	-	V/V
	Output Resistance	$R_{out}$	-	200	-	ohms
 <p> <math>V_{in}</math>  <math>I_o</math> </p>	Differential Voltage Range	$V_{in}$	$\pm 5.0$	-	-	Vdc
	Positive Output Voltage $V_{in} \geq 10$ mVdc, $0 \leq I_o \leq 0.5$ mA	$V_{OH}$	2.5	3.2	5.0	Vdc
	Negative Output Voltage $V_{in} \leq -10$ mVdc	$V_{OL}$	-1.0	-0.5	0	Vdc
	Strobed Output Level $V_{strobe} \leq 0.3$ Vdc	$V_{OL(st)}$	-1.0	-	0	Vdc
	Output Sink Current $V_{in} \geq -10$ mV, $V_{out} \geq 0$	$I_S$	0.5	0.8	-	mAdc
 <p> <math>V_{in}</math>  <math>I_{st}</math> </p>	Strobe Current $V_{strobe} = 100$ mVdc	$I_{st}$	-	1.2	2.5	mAdc
	Input Common Mode Range $V^- = -7.0$ Vdc	$CM_{Vin}$	$\pm 5.0$	-	-	Volts
 <p> <math>e_{in}</math>  <math>e_{out}</math>  <math>e_{strobe}</math>  <math>t_R</math>  <math>t_{SR}</math> </p>	Response Time $V_b = 5.0$ mV + $V_{io}$	$t_R$	-	40	-	ns
		$t_R$	-	40	-	ns
	Strobe Release Time	$t_{SR}$	-	12	-	ns
 <p> <math>V_{in}</math>  <math>I_{D+}</math>  <math>I_{D-}</math> </p>	Power Supply Current $V_{out} \leq 0$ Vdc	$I_{D+}$ $I_{D-}$	-	8.6	-	mAdc
	Power Consumption		-	130	200	mW

TYPICAL CHARACTERISTICS

FIGURE 1 – VOLTAGE TRANSFER CHARACTERISTICS

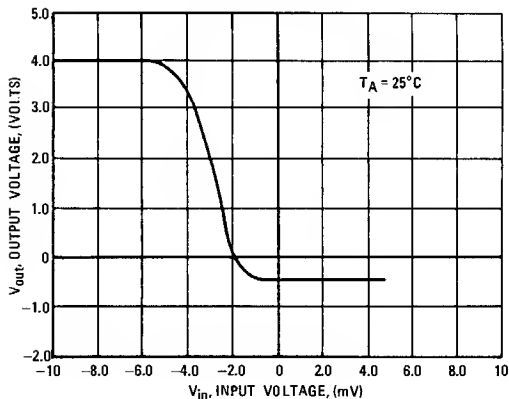


FIGURE 2 – INPUT BIAS CURRENT versus TEMPERATURE

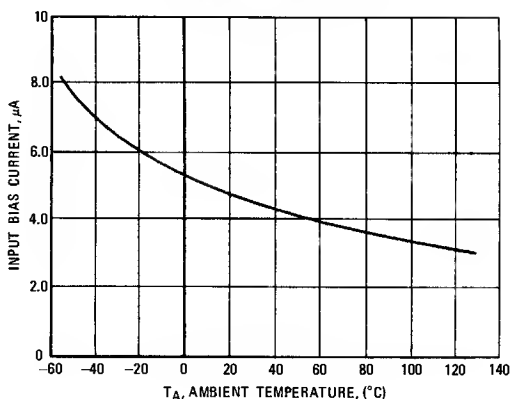


FIGURE 3 – VOLTAGE GAIN versus TEMPERATURE

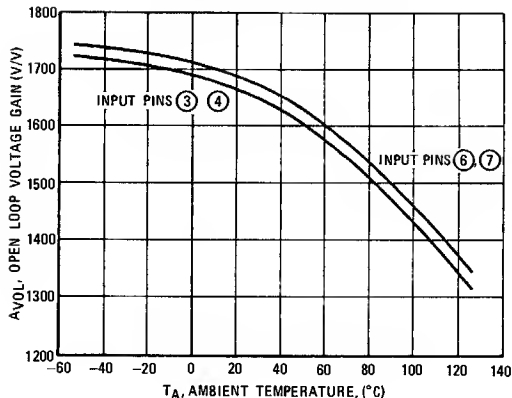


FIGURE 4 – RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES

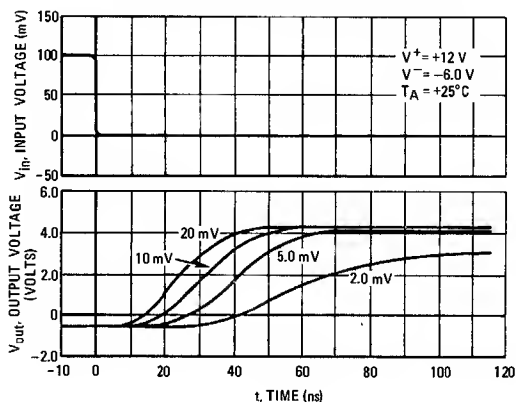


FIGURE 5 – VOLTAGE GAIN VARIATION WITH POWER SUPPLY VOLTAGE

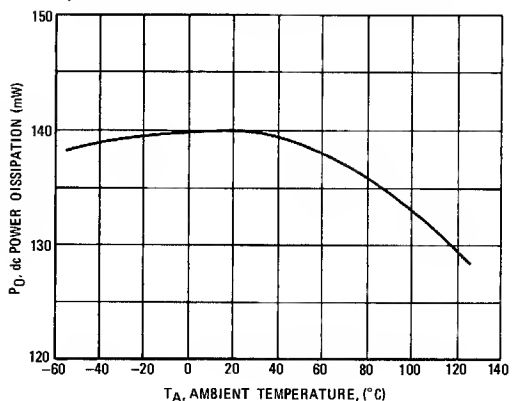


FIGURE 6 – STROBE RELEASE TIME FOR VARIOUS INPUT OVERDRIVES

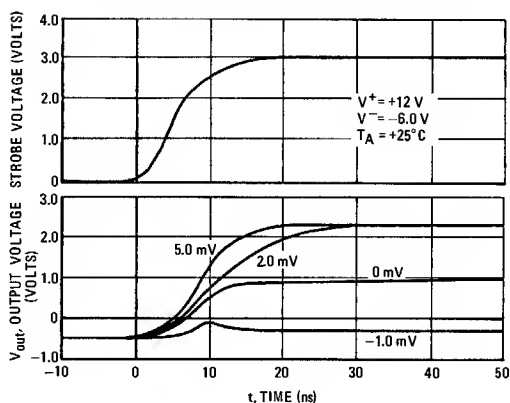


FIGURE 7 – COMMON MODE PULSE RESPONSE

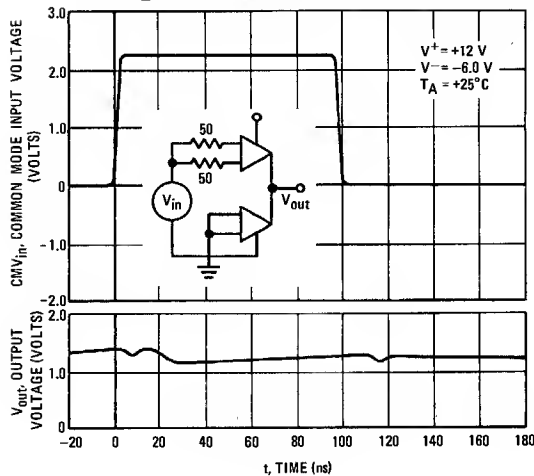


FIGURE 8 – OUTPUT PULSE STRETCHING WITH CAPACITIVE LOADING

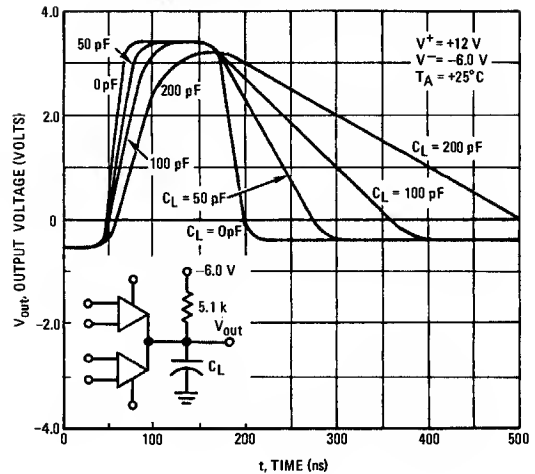


FIGURE 9 – SERIES RESISTANCE versus MRTL FAN-OUTS

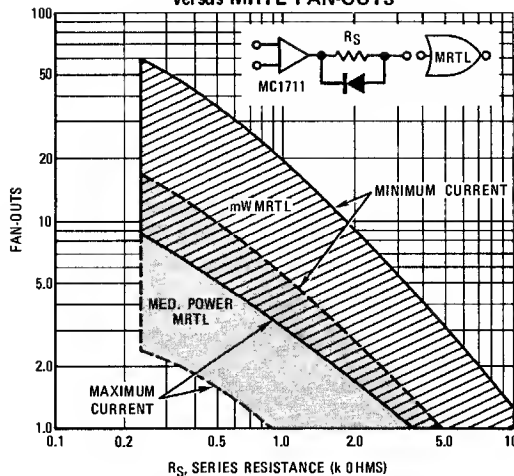
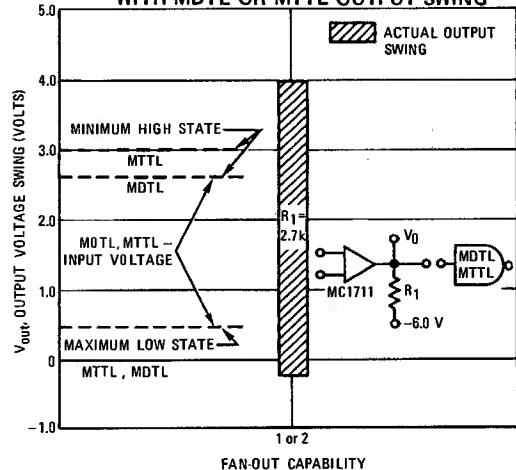


FIGURE 10 – FAN-OUT CAPABILITY WITH MDTL OR MTTL OUTPUT SWING





# DUAL DIFFERENTIAL COMPARATOR

# SENSE AMPLIFIERS

## MC1711C

... designed for use in level detection, low level sensing, and memory applications.

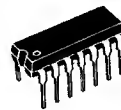
Lead 5 connected  
to case



CASE 71A  
"G" SUFFIX



CASE 72  
(TO-91)  
"F" SUFFIX



CASE 93  
(TO-116)  
"P" SUFFIX

### Typical Amplifier Features:

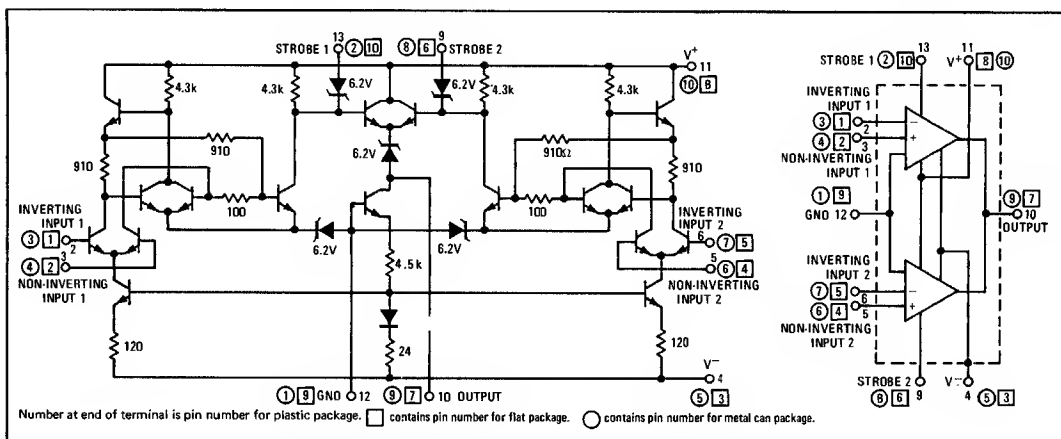
- Differential Input  
Input Offset Voltage = 1.0 mV  
Offset Voltage Drift = 5.0  $\mu\text{V}/^\circ\text{C}$
- Fast Response Time — 40 ns
- Output Compatible with All Saturating Logic Forms  
 $V_{\text{out}} = +4.5 \text{ V}$  to  $-0.5 \text{ V}$  typical
- Low Output Impedance — 200 ohms

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$ $V^-$	+14 -7.0	Vdc
Differential Input Signal	$V_{\text{in}}$	$\pm 5.0$	Volts
Common Mode Input Swing	$\text{CMV}_{\text{in}}$	$\pm 7.0$	Volts
Peak Load Current	$I_L$	50	mA
Power Dissipation (package limitation)	$P_D$		
Metal Can Derate above $T_A = 25^\circ\text{C}$		680 4.6	mW $\text{mW}/^\circ\text{C}$
Flat Package Derate above $T_A = 25^\circ\text{C}$		500 3.3	mW $\text{mW}/^\circ\text{C}$
Plastic Package Derate above $T_A = 25^\circ\text{C}$		400 3.3	mW $\text{mW}/^\circ\text{C}$
Operating Temperature Range	$T_A$	0 to +75	$^\circ\text{C}$
Storage Temperature Range	$T_{\text{stg}}$	-65 to +150 -65 to +125	$^\circ\text{C}$

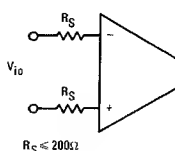
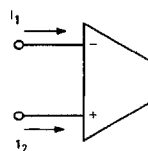
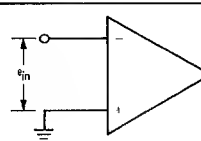
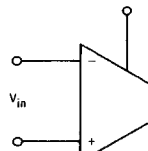
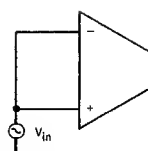
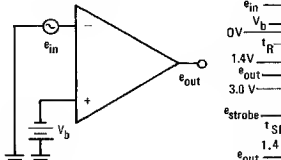
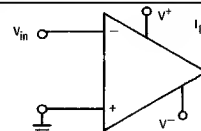
### CIRCUIT SCHEMATIC

### EQUIVALENT CIRCUIT



# MC1711C (continued)

**ELECTRICAL CHARACTERISTICS** (each comparator)  $V^+ = +12$  Vdc.  $V^- = -6.0$  Vdc.  $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic Definitions	Characteristic	Symbol	Min	Typ	Max	Unit
 <p><math>V_{io}</math></p> <p><math>R_S \leq 200\Omega</math></p> <p><math>V_{out} = 1.4</math> Vdc @ <math>25^\circ\text{C}</math>  <math>V_{out} = 1.5</math> Vdc @ <math>0^\circ\text{C}</math>  <math>V_{out} = 1.2</math> Vdc @ <math>+70^\circ\text{C}</math></p>	Input Offset Voltage $CMV_{in} = 0$ Vdc, $T_A = -25^\circ\text{C}$ $CMV_{in} \neq 0$ Vdc, $T_A = +25^\circ\text{C}$ $CMV_{in} = 0$ Vdc, $T_A = 0$ to $+70^\circ\text{C}$ $CMV_{in} \neq 0$ Vdc, $T_A = 0$ to $+70^\circ\text{C}$	$V_{io}$	-	1.0	5.0	mVdc
	Temperature Coefficient of Input Offset Voltage	$TC_{V_{io}}$	-	5.0	-	$\mu\text{V}/^\circ\text{C}$
 <p><math>I_1</math></p> <p><math>I_2</math></p> <p><math>I_{io} = I_1 - I_2</math></p> <p><math>I_b = \frac{I_1 + I_2}{2}</math></p>	Input Offset Current $V_{out} = 1.4$ Vdc, $T_A = +25^\circ\text{C}$ $V_{out} = 1.5$ Vdc, $T_A = 0^\circ\text{C}$ $V_{out} = 1.2$ Vdc, $T_A = +70^\circ\text{C}$	$I_{io}$	-	0.5	15	$\mu\text{A}$ dc
	Input Bias Current $V_{out} = 1.4$ Vdc, $T_A = +25^\circ\text{C}$ $V_{out} = 1.5$ Vdc, $T_A = 0^\circ\text{C}$ $V_{out} = 1.2$ Vdc, $T_A = +70^\circ\text{C}$	$I_b$	-	25	100	$\mu\text{A}$ dc
 <p><math>A_{VOL} = \frac{e_{out}}{e_{in}}</math></p> <p><math>R_{out}</math></p>	Voltage Gain $T_A = +25^\circ\text{C}$ $T_A = -55$ to $+125^\circ\text{C}$	$A_{VOL}$	700	1500	-	V/V
	Output Resistance	$R_{out}$	-	200	-	ohms
 <p><math>V_{in}</math></p> <p><math>I_s</math></p> <p><math>I_o</math></p>	Differential Voltage Range	$V_{in}$	$\pm 5.0$	-	-	Vdc
	Positive Output Voltage $V_{in} \geq 10$ mVdc, $0 \leq I_o \leq 0.5$ mA	$V_{OH}$	2.5	3.2	5.0	Vdc
	Negative Output Voltage $V_{in} \leq -10$ mVdc	$V_{OL}$	-1.0	-0.5	0	Vdc
	Strobed Output Level $V_{strobe} \leq 0.3$ Vdc	$V_{OL(st)}$	-1.0	-	0	Vdc
	Output Sink Current $V_{in} \geq -10$ mV, $V_{out} \geq 0$	$I_S$	0.5	0.8	-	mAdc
 <p><math>V_{in}</math></p>	Strobe Current $V_{strobe} = 100$ mVdc	$I_{st}$	-	1.2	2.5	mAdc
	Input Common Mode Range $V^- = -7.0$ Vdc	$CM_{V_{in}}$	$\pm 5.0$	-	-	Volts
 <p><math>e_{in}</math></p> <p><math>V_b</math></p> <p><math>e_{out}</math></p> <p><math>t_R</math></p> <p><math>t_{SR}</math></p> <p><math>e_{strobe}</math></p> <p><math>1.4</math> V</p> <p><math>1.4</math> V</p>	Response Time $V_b = 5.0$ mV + $V_{io}$	$t_R$	-	40	-	ns
	Strobe Release Time	$t_{SR}$	-	12	-	ns
 <p><math>V_{in}</math></p> <p><math>V^+</math></p> <p><math>V^-</math></p> <p><math>I_{D^+}</math></p> <p><math>I_{D^-}</math></p>	Power Supply Current $V_{out} \leq 0$ Vdc	$I_{D^+}$	-	8.6	-	mAdc
	Power Consumption	$I_{D^-}$	-	3.9	-	mW

TYPICAL CHARACTERISTICS

FIGURE 1 – VOLTAGE TRANSFER CHARACTERISTICS

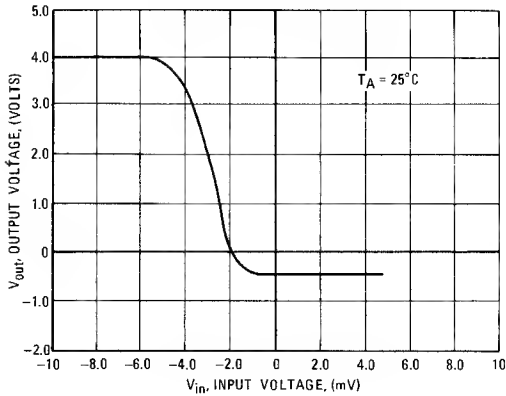


FIGURE 2 – INPUT BIAS CURRENT versus TEMPERATURE

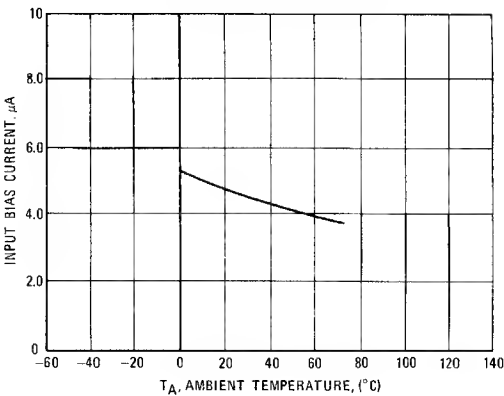


FIGURE 3 – VOLTAGE GAIN versus TEMPERATURE

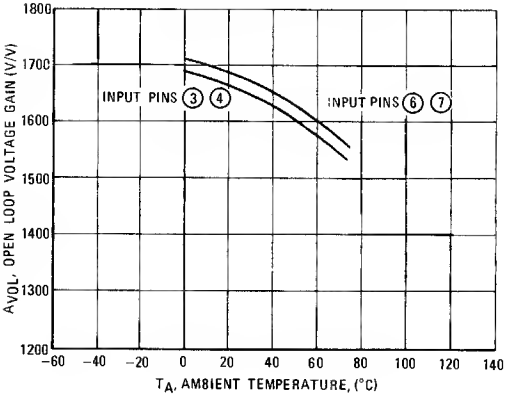


FIGURE 4 – RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES

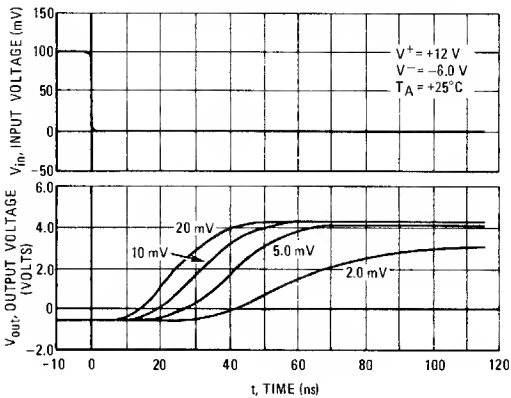


FIGURE 5 – VOLTAGE GAIN VARIATION WITH POWER SUPPLY VOLTAGE

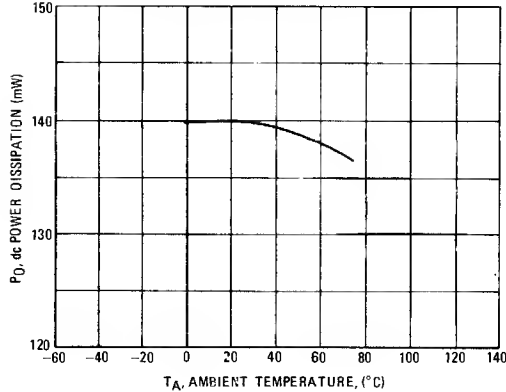
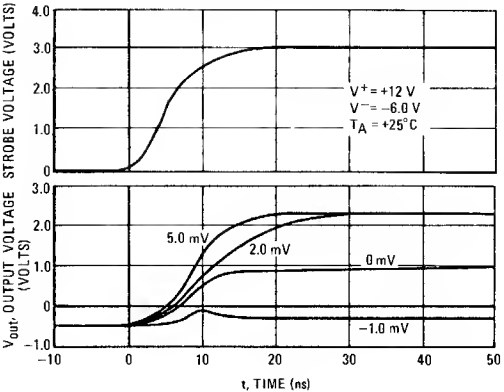


FIGURE 6 – STROBE RELEASE TIME FOR VARIOUS INPUT OVERDRIVES



# MC1711C (continued)

FIGURE 7 – COMMON MODE PULSE RESPONSE

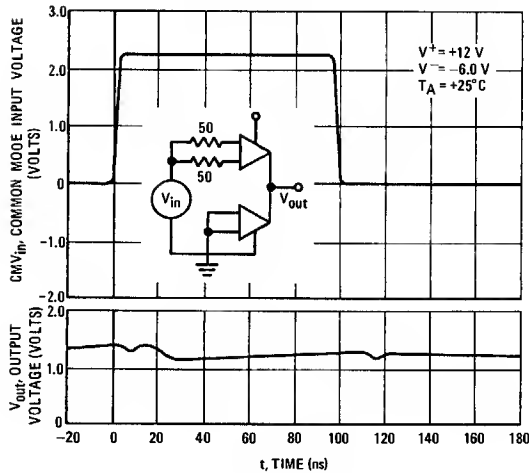


FIGURE 8 – OUTPUT PULSE STRETCHING WITH CAPACITIVE LOADING

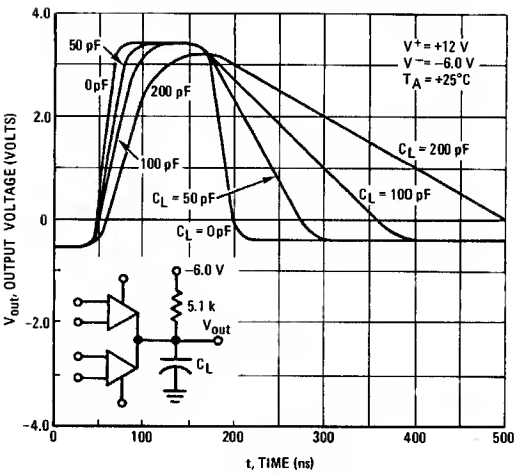


FIGURE 9 – SERIES RESISTANCE versus MRTL FAN-OUTS

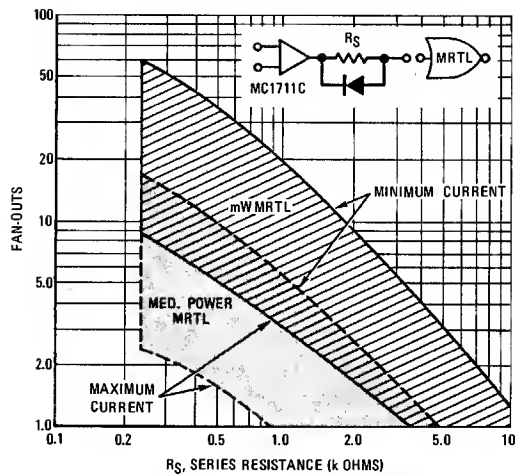
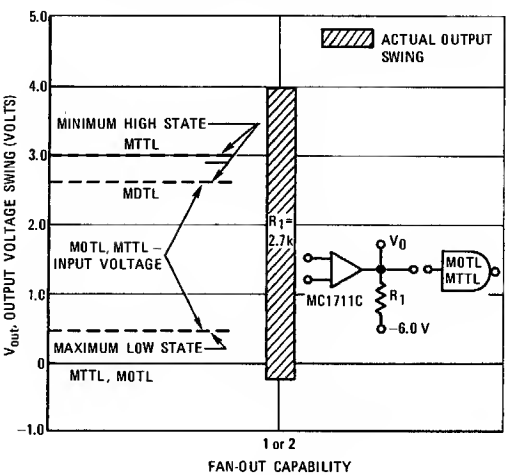


FIGURE 10 – FAN-OUT CAPABILITY WITH MDTL OR MTTL OUTPUT SWING



## DUAL STEREO PREAMPLIFIER

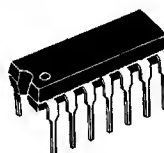
## STEREO PREAMPLIFIERS

### MC1303P

... designed for amplifying low-level stereo audio signals with two preamplifiers built into a single monolithic semiconductor.

#### Each Preamplifier Features:

- Low Input Noise Voltage —  $0.5 \mu\text{V}$  typical
- Large Output Voltage Swing —  $4.5 \text{ V rms min}$
- High Open-Loop Voltage Gain = 8,000 min
- Channel Separation = 60 dB min at 10 kHz
- Short-Circuit-Proof Design

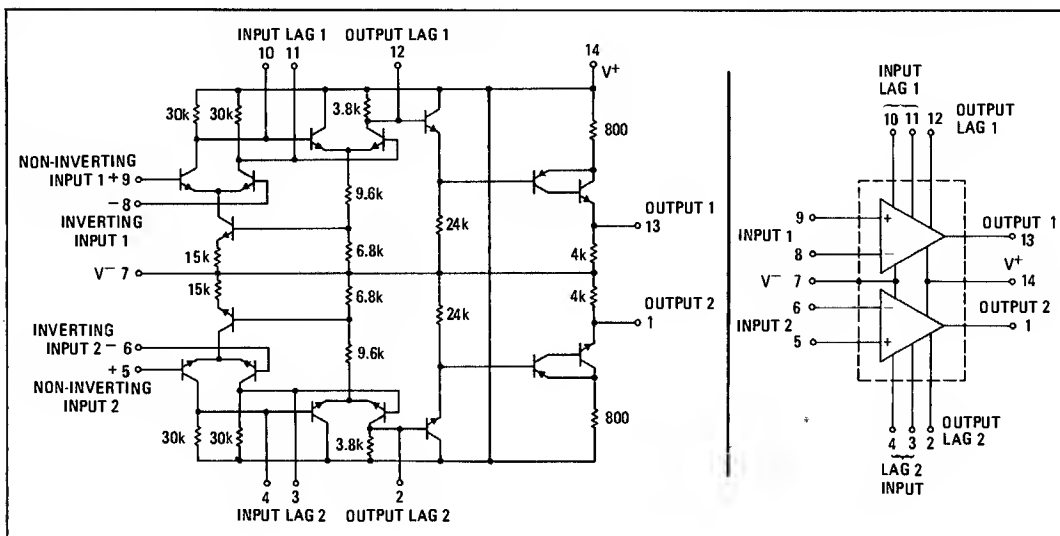


CASE 93  
(TO-116)  
"P" SUFFIX

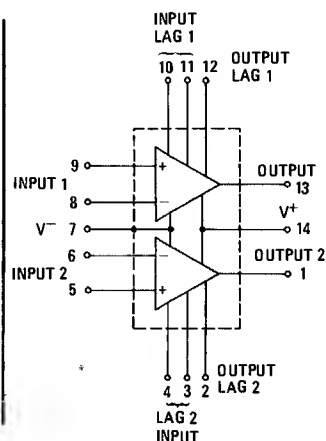
#### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V^+$	+15	Vdc
	$V^-$	-15	Vdc
Power Dissipation (Package Limitation) Derate above $25^\circ\text{C}$	$P_D$	415	mW
		3.3	$\text{mW}/^\circ\text{C}$
Operating Temperature Range	$T_A$	0 to +75	$^\circ\text{C}$

#### CIRCUIT SCHEMATIC

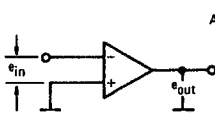

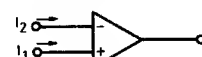
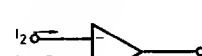
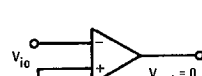
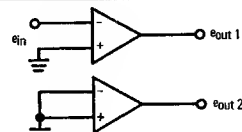


#### EQUIVALENT CIRCUIT



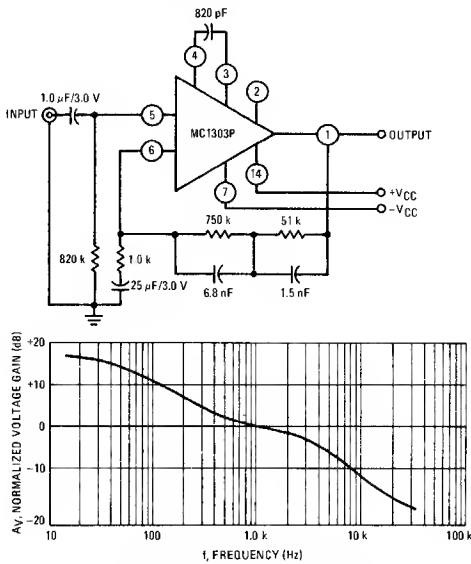
# MC1303P (continued)

## ELECTRICAL CHARACTERISTICS (Each Preamplifier) ( $V^+ = +13$ Vdc, $V^- = -13$ Vdc, $T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic Definitions (linear operations)	Characteristic	Symbol	Min	Typ	Max	Unit
 $A_{VOL} = \frac{e_{out}}{e_{in}}$	Open Loop Voltage Gain	$A_{VOL}$	8,000	10,000	12,000	V/V
	Output Voltage Swing ( $R_L = 10$ k $\Omega$ )	$V_{out}$	4.5	5.5	-	V rms
	Input Bias Current $I_b = \frac{I_1 + I_2}{2}$	$I_b$	-	1.0	10	$\mu\text{A}$
	Input Offset Current ( $I_{io} = I_1 - I_2$ )	$I_{io}$	-	0.2	0.4	$\mu\text{A}$
	Input Offset Voltage	$V_{io}$	-	1.5	10	mV
	DC Power Dissipation (Power Supply $\approx \pm 13$ V, $V_{out} = 0$ )	$P_D$	-	-	300	mW
	Channel Separation ( $f = 10$ kHz)	$\frac{e_{out 1}}{e_{out 2}}$	60	70	-	dB

TYPICAL PREAMPLIFIER APPLICATIONS

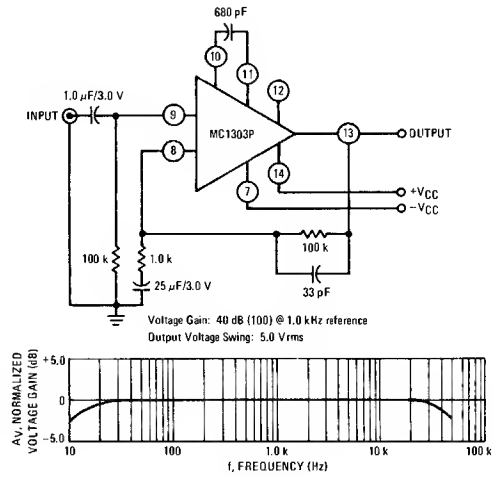
FIGURE 1 — MAGNETIC PHONO PLAYBACK  
PREAMPLIFIER/RIAA EQUALIZED



TYPICAL PERFORMANCE CHARACTERISTICS

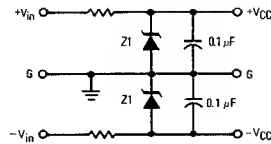
Voltage Gain	34 dB (50) @ 1.0 kHz
Input Overload Point	100 mVrms @ 1.0 kHz
Output Voltage Swing	5.0 Vrms @ 1.0 kHz @ 0.1% THD
Output Noise Level	Better Than 70 dB Below 10 mV Phono Input (Input Shorted)

FIGURE 2 — BROADBAND AUDIO AMPLIFIER



Voltage Gain: 40 dB (100) @ 1.0 kHz reference  
Output Voltage Swing: 5.0 Vrms

SUGGESTED POWER SUPPLY CIRCUIT



Z1 = MZ-600-19  
(1.3 V nom.)  
Select series R by  
allowing 11 mA for  
zener, and each dual  
I/C Preamplifier

FIGURE 3 — NAB TAPE HEAD EQUALIZATION

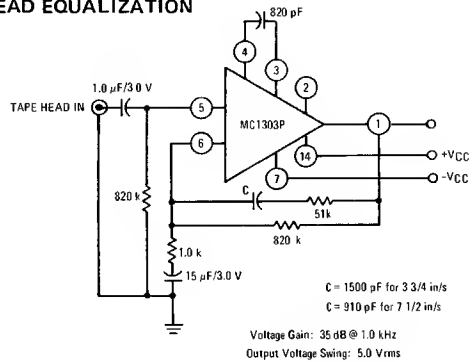
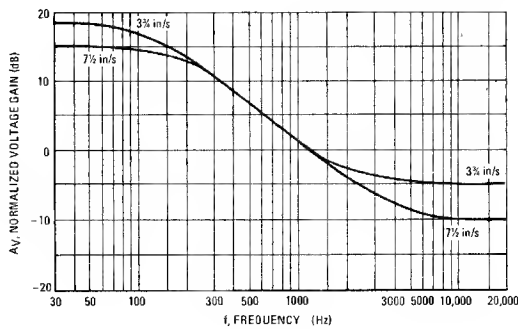


FIGURE 4 – POWER DISSIPATION versus SUPPLY VOLTAGE

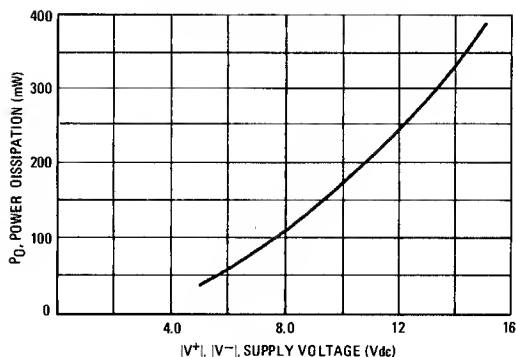


FIGURE 5 – OUTPUT LINEARITY

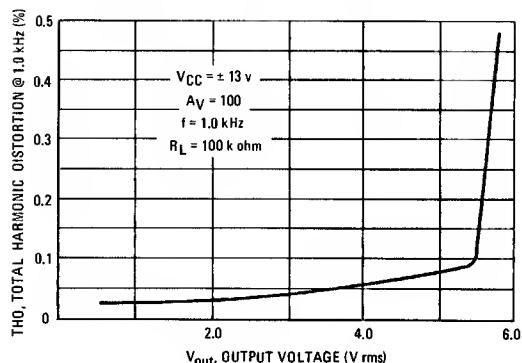
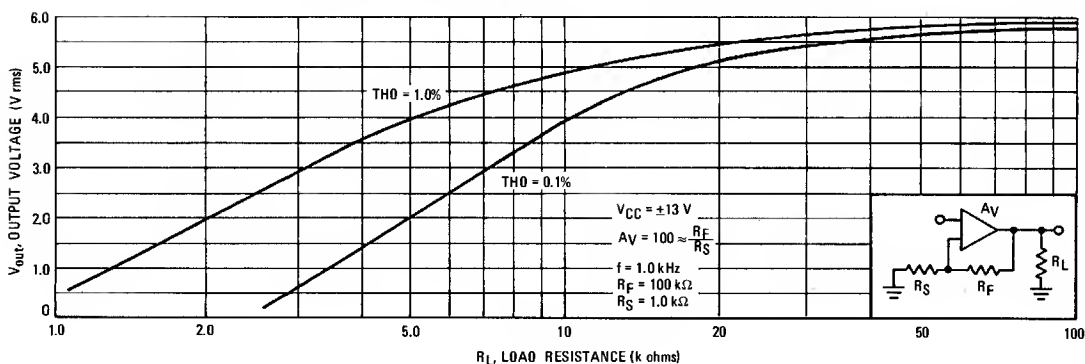


FIGURE 6 – INFLUENCE OF OUTPUT LOADING



## NOISE CHARACTERISTICS

FIGURE 7A – INFLUENCE OF SOURCE RESISTANCE & BANDWIDTH

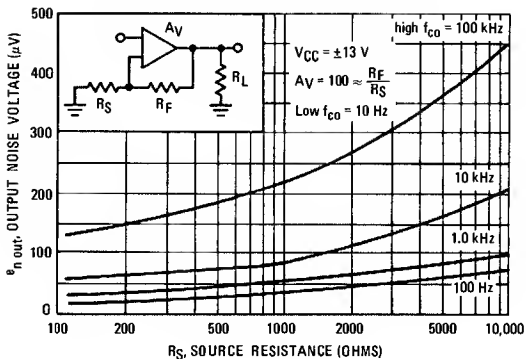
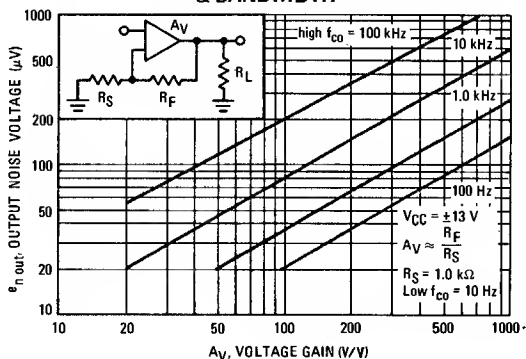


FIGURE 7B – INFLUENCE OF VOLTAGE GAIN & BANDWIDTH





## ADDITIONS AND MODIFICATIONS

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